



**HP64000  
Logic Development  
System**

**Model 64161A/162A/163A  
Emulation Memory**

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 HEWLETT  
PACKARD

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*Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.*

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HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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## **ASSISTANCE**

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.*

*For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.*

## SERVICE MANUAL

MODEL 64161A/162A/163A

EMULATION MEMORY

### REPAIR NUMBERS

This manual applies to Model 64161A all repair number prefixes. For more information on repair numbers refer to "Instruments Covered by This Manual" in Section I.

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COLORADO SPRINGS, COLORADO, U.S.A.

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## **SAFETY SUMMARY**

*The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.*

### **GROUND THE INSTRUMENT.**

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

### **DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.**

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

### **KEEP AWAY FROM LIVE CIRCUITS.**

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

### **DO NOT SERVICE OR ADJUST ALONE.**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

### **DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

### **DANGEROUS PROCEDURE WARNINGS.**

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

**WARNING**

**Dangerous voltages, capable of causing death, are present in this instrument.  
Use extreme caution when handling, testing, and adjusting.**

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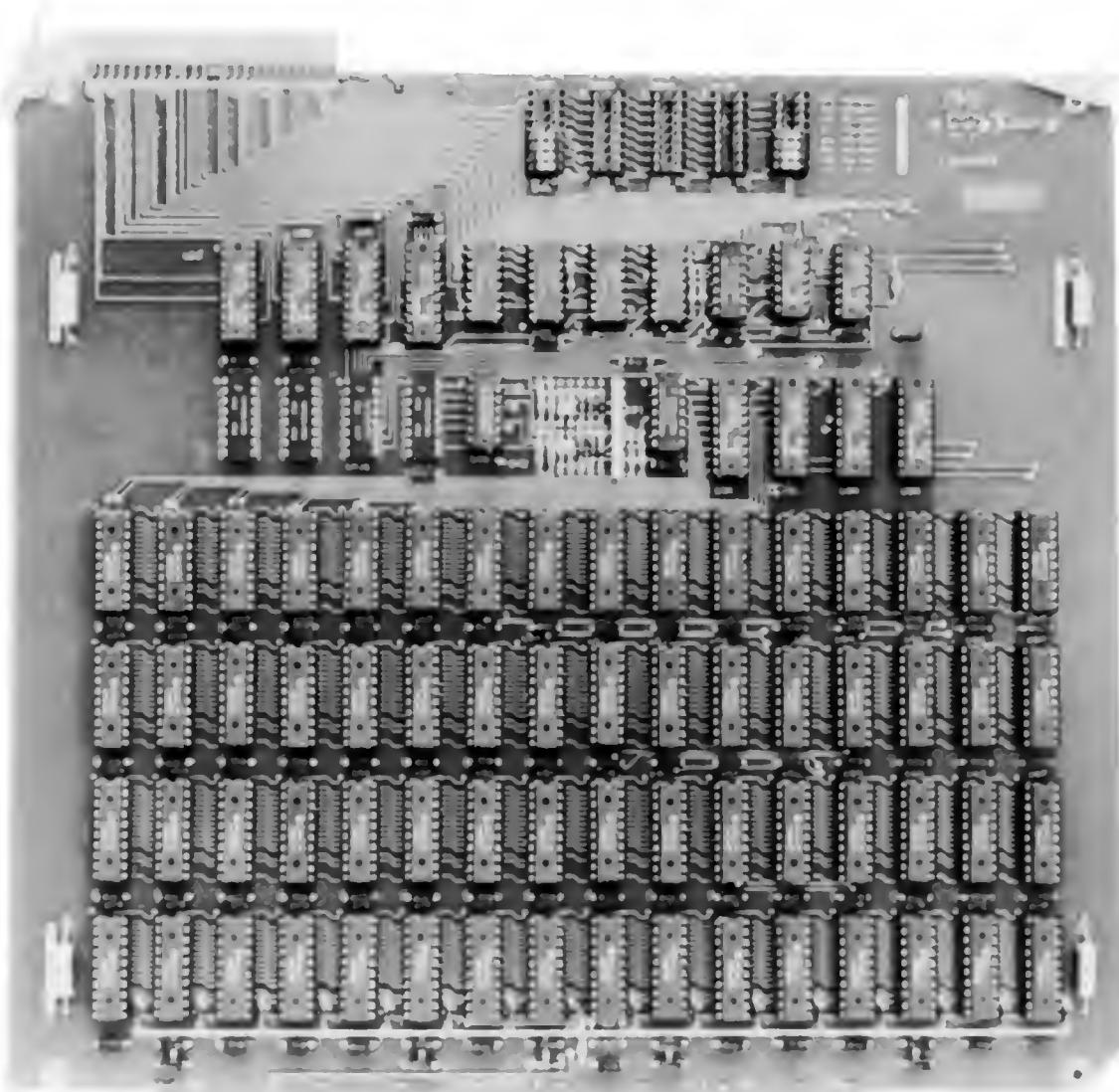


Figure 1-1. Model 64161A/162A/163A Emulation Memory

## SECTION I

## GENERAL INFORMATION

## 1-1. INTRODUCTION.

1-2. This Service Manual contains information required to install, test and service the Hewlett-Packard Model 64161A/162A/163A Emulator Memory.

Service information contained in this manual allows the user to isolate functional problems to the board level. This or to the component level. Board level troubleshooting is in support of the Hewlett-Packard Bluestripe board exchange program.

1-3. Shown on the title page is a microfiche part number. This number can be used to order a 4 X 6-inch microfilm transparency of the manual. Each microfiche contains up to 96 photoduplicates of the manual pages.

## 1-4. INSTRUMENTS COVERED BY THIS MANUAL.

1-5. Attached to the instrument or printed on the printed circuit board is the repair number. The repair number is in the form: 0000A0000. It is in two parts; the first four digits and the letter are the repair prefix, and the last five are the suffix. The prefix is the same for all identical instruments. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the repair number prefix(es) listed under REPAIR NUMBERS on the title page.

1-6. An instrument manufactured after the printing of this manual may have a repair number prefix that is not listed on the title page. This unlisted repair number prefix indicates that the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a Manual Changes Supplement. The supplement contains "change information" that explains how to adapt the manual for the newer instrument.

1-7. In addition to change information, the supplement contains information for correcting errors in the manual. To keep this manual as current as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes Supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-8. For information concerning a repair number prefix that is not listed on the title page or in the Manual Changes Supplement, call your nearest Hewlett-Packard office.

### 1-9. DESCRIPTION.

1-10. The 64000 microprocessor emulation systems, illustrated in Figure 1-2, allow software designers to develop and debug software modules for specific microprocessors. The emulation plug replaces the microprocessor physically in the target system permitting hardware in the emulation system to simulate the functions of the target microprocessor while driving target system hardware with the software being developed.

1-11. The emulation memory can be used to duplicate the target system memory. Address space can be allocated to target system RAM, target system ROM, emulation RAM, and emulation ROM, and illegal address space.

1-12. Models 64161A, 64162A, and 64163A Emulation Memory provide the possibility of up to 128K bytes of memory on one card. The three models differ from each other in the number of memory chips loaded on each board. The Model 64163A, 32k byte memory, has one 16-chip row of 16K x 1 static RAM chips loaded; Model 64162A, 64k byte memory, has two rows of chips loaded and the Model 64161A, 128k byte memory has four rows of chips.

1-13. The 64161A, 64162A and 64163A feature fast access time, low-power standby and operation modes, and the ability to access bytes as well as 16-bit words.

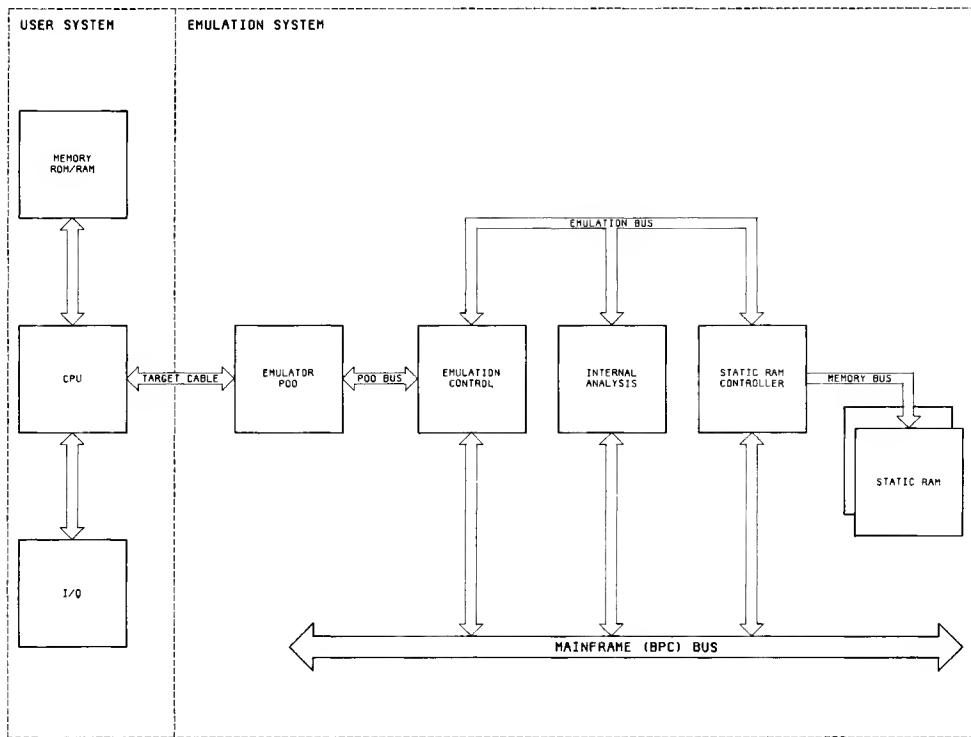


Figure 1-2. Emulation Subsystem

1-14. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1-15. A 64151 or 64155-66502 Memory Control Board is required to drive the 64161A, 64162A, or 64163A Emulator Memories.

1-16. TEST EQUIPMENT.

1-17. Table 1-1 lists the test equipment needed to repair and maintain Models 64161A/162A/163A.

Table 1-1

INSTRUMENT	RECOMMENDED MODEL	USE
Dual-trace Oscilloscope	HP1740A	Troubleshooting
Digital Voltmeter	HP3465A	Troubleshooting
64000 Extender Card	64100-66510	Troubleshooting
64000 Extender Cables (2)	8120-3350	Troubleshooting
Signature Analyzer	HP5004A, HP5005A	Troubleshooting
Memory Controller	HP64151A, HP64155	Troubleshooting

1-18. SPECIFICATIONS.

1-19. Specifications for the Model 64161A/162A/163A are listed in Table 1-2.

Table 1-2. Specifications.

	64161A	64162A	64163A
Power (Max Typ) mW			
0 rows selected	5283.7	5285.7	5285.7
1 row selected	8161.8	8163.7	8167.5
Current (Max Typ) mA			
0 rows selected	1056.7	1057.1	1057.9
1 row selected	1632.3	1632.7	1633.5

**1-20. RELATED MANUALS.**

**1-21. Service Manuals.**

**64151A Memory Control Service Manual  
64155 Memory Control Service Manual  
64152A 32K Memory Service Manual**

## SECTION II

## INSTALLATION

## 2-1. INTRODUCTION.

2-2. This section contains information for installing and removing the Model 64161A/162A/163A. Included are initial inspection procedures and instructions for repacking the instrument for shipment.

## 2-3. INITIAL INSPECTION.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the Performance Tests, notify the nearest Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement at HP's option without waiting for claim settlement.

## 2-5. INSTALLATION.

## NOTE

If the following installation procedures are not followed, imaging problems may result.

2-6. The Models 64161A/162A/163A Emulation Memory Boards are installed using the following procedure. Figures 2-1 and 2-2 shows the recommended location of the emulation option boards in the HP64000 mainframes for two typical configurations: Emulation Memory only and Emulation Memory with Analysis. Note that with emulators which use the 64271A or 64274A Control Card, an analyzer is required; therefore, ignore the configurations shown without an analyzer when installing these emulator control cards.

- a. Turn off power to the 64000 station.
- b. Loosen the two hold-down screws and remove the card cage access cover (64100A). (Refer to 64110A Mainframe Service Manual for information on removing the card cage access cover of the 64110A.)
- c. Install the emulation subsystem (control card and pod). Refer to the appropriate service manuals for the emulator concerned.

- d. If an analyzer module (64300A or 64302A) is to be used, install it at this time. Refer to the 64300A/64302A Service Manuals for installation instructions.
- e. Install the Memory Controller Module (64151A or 64155). Refer to the Service Manual for the Memory Controller in use for installation instructions. Do not install the Emulation Memory Boards or ribbon cables. This will be done later.
- f. The address range jumpers on the Emulation Memory Boards must now be configured to select the base address range of each Memory Board (64161A/162A/163A) used in the mainframe. The address range selection is dependent on the number of Memory Boards installed in the development station. Refer to Table 2-1 through 2-4 and Figure 2-3 for information on where jumpers should be installed.
- g. Once the address range jumper on each board is in the proper position, the Memory Boards must be installed in the development station. (Please refer to the Memory Space Configuration in the paragraphs beginning at 2-7 before installing your memory system.) Hold the board by the extractor levers, with the component side of the board facing the front of the development station, and the large motherboard connector (labeled "P1") pointing towards the bottom of the station. Insert the board in the guide rails of the desired slot and push down until the P1 connector seats firmly in the motherboard connector at the bottom of the station.
- h. Connect the Emulation Memory Bus ribbon cable across the left-hand set of edge connectors (as you face the front of the development station). The bus cables are keyed so that they will fit on the edge connectors in only one position.
- i. Connect the Emulation Bus cables across the two right-hand sets of edge connectors (as you face the front of the development station). The bus cables are keyed so that they will fit on the edge connectors in only one position.
- j. Reinstall the card cage access cover and tighten the 2 screws (64100A). (Refer to the 64110A Mainframe Service Manual for information on replacing the card cage access cover of the 64110A.)

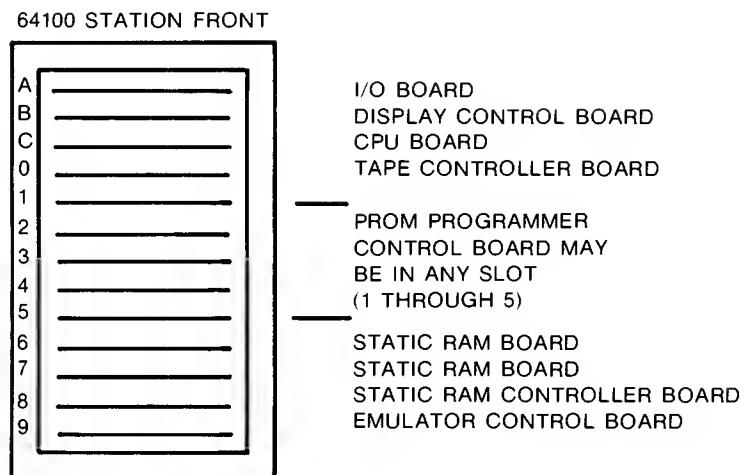


Figure 2-1. Emulation Memory Installation  
(with 6416X series memory only)

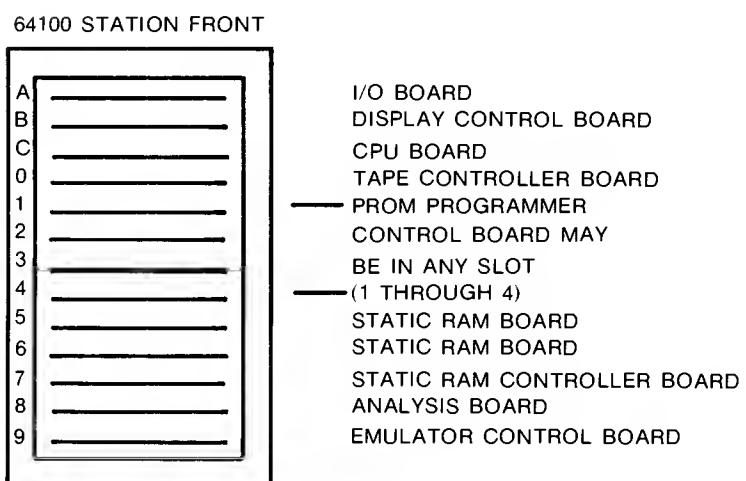
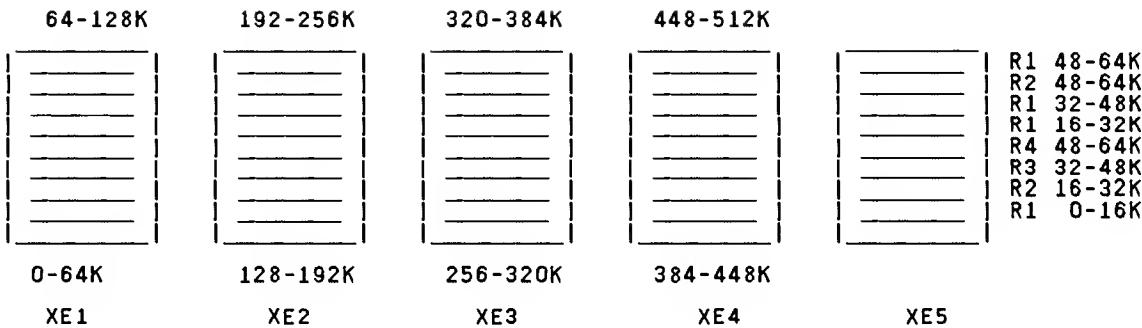


Figure 2-2. Emulation Memory Installation with Analysis



XE1-4 determine the addressable range of the Memory Card. The primary purpose for XE5 is to configure the 6416X series Memory to be compatible with the 6415X series Memory. XE5 performs row mapping. The following guidelines will help you avoid memory mapping errors.

#### When using 6416X series Memory Cards only.

1. The memory space defined by the 8-pin DIP jumper in XE1-4 may not overlap the address space assigned to any other memory card in systems using 64161A.
2. When using the 64161A the jumper in XE5 must be in the row 1-4.
3. When using a mixture of 64162A and 64163A cards the address space assigned in XE5 must not overlap when more than one card is assigned to the same address space in XE1-4.

#### When using a mixture of 6416X and 6415X Memory Cards.

1. When combining 6416X and 6415X Memory Cards you cannot assign address space higher than 64K words.
2. Be certain that the address space assigned to one card does not overlap the address space assigned to any other card.
3. Follow the configuration guides in Table 2-1 to Table 2-4.  
Figure 2-3. Address Range Jumper Installation

## 2-7. MEMORY SPACE CONFIGURATION GUIDE

## 2-8. MEMORY SPACE CONFIGURATIONS WITH THE 64151A STANDARD MEMORY CONTROLLER

## Model 64161A

64161A (128k bytes) cannot be attached to a 64151A memory controller that is attached to any of the 64152A/3A/4A or 64152B/3B/4B memory boards. A 64161A Memory Board must have an 8-pin DIP jumper in row 1-4 of XE5. Another 8-pin DIP jumper must be located in the 0-64k address range position in XE1.

## Model 64162A

The 64162A (32K words) would normally be all the memory that could be used with the 64151A Memory Controller. Although the 64151A can be configured for 16 bit operation, the Model 64155A is usually recommended for 16 bit emulation. If your 16-bit emulation system permits the use of the 64151A Memory Controller, follow the configuration guide listed in Table 2-2 to expand to 64K words of memory.

## Model 64163A

One of these boards may be attached to a Model 64151A along with one of the 64152/3/4 memory boards. If 6416X and 6415X memory boards are used together install the 6416X memory boards next to the 64151A Memory Controller. The 8-pin DIP jumper on the 64163A must be in XE1 in the position labeled 0-64K; the single jumper must be in XE5, in a position labeled R1. The address space of the 64152/3/4 memory boards being used must not overlap the address space assigned to the 64163A. Possible combinations of the 64163A and 64152/3/4 memory boards are listed in Table 2-1. Refer to Table 2-3 to assign address space to 64k word configurations when using the 64163A. The 8-pin DIP jumper must be in XE1, address range 0-64k on the 64162A board. The two single jumpers must be in XE5; one must be in a position labeled R1 and the other must be in a position labeled R2. The address space of R1 and R2 must not overlap. With 16-bit emulation two 64162A cards may be used.

Table 2-1.

	64163 row 1	64152/3/4
1	0-16K	16-32K
2	16-32K	0-16K

2-9. MEMORY CONFIGURATIONS WITH THE 64155A WIDE MEMORY CONTROLLER  
 (with the 6416X memory you must use the 64155-66502 version)

## Model 64161A

64161A (128k bytes) cannot be attached to a 64155A Memory Controller that is attached to any of the 64152/3/4 Memory Boards. A 64161A Memory Board must have a 8-pin DIP jumper in row 1-4 of XE5. Another 8-pin DIP jumper must be located in any one of the eight possible address range positions in XE1-XE4.

## Model 64162A

The 64162A (64k bytes) can be used with a memory controller which has 64152A/64153A/64154A and/or 64152B/64153B/64154B Memory Boards. If 6416X and 6415X memory boards are used together DO NOT install the 6416X memory boards next to the 64155A Memory Controller. The 8-pin DIP jumper must be in XE1, address range 0-64k on the 64162A board. The two single jumpers must be in XE5; one must be in a position labeled R1 and the other must be in a position labeled R2. The address space of labels R1 and R2 must not overlap. The address space of the 64152/153/154 must not overlap the address space of the 64162A. A sample of address range configurations are listed in Table 2-2.

Table 2-2.

	64162 row 1	64162 row 2	64152/3/4	64152/3/4
1*	0-16k	16-32k	32-48k	48-64k
2*	0-16k	48-64k	16-32k	32-48k
3+	16-32k	48-64k	0-16k	32-48k
4+	32-48k	16-32k	0-16k	48-64k
5+	32-48k	48-64k	0-16k	16-32k
6+	48-64k	16-32k	0-16k	32-48k

\*In configuration 1 and 2 if there is only one 64152/3/4 it can occupy either address space listed for the 64152/3/4 boards.

+In configurations 3-6 there must be a block of memory with physical location at 0-16k; if there is only one 64152/3/4 it must be set to location 0-16k.

## Model 64163A

One, two, or three of these boards can be attached to a memory control board along with three, two or one of the 64152/3/4 memory boards. If 6416X and 6415X memory boards are used together DO NOT install the 6416X memory boards next to the 64155 Memory Controller.

The 8-pin DIP jumper on the 64163A must be in XE1 in the position labeled 0-64k; Each board has a single jumper which must be put in a position labeled R1. If more than one of the 64163A Memory Boards are being used the address space of the R1 labels must not overlap.

The address space of the 64152/3/4 memory boards being used must not overlap the address space assigned to the 64163A memory boards being used. Possible combinations of 64152/3/4 memory boards and 64163A memory boards are listed in Table 2-3.

Table 2-3.

	64163 row 1	64152/3/4	64152/3/4	64152/3/4
1*	0-16k	16-32k	32-48k	48-64k
2+	16-32k	0-16k	32-48k	48-64k
3+	32-48k	0-16k	16-32k	48-64k
4+	48-64k	0-16k	16-32k	32-48
	64163 row 1	64163 row 1	64152/3/4	64152/3/4
5*	0-16k	16-32k	32-48k	48-64k
6*	0-16k	32-48k	16-32k	48-64k
7*	0-16k	48-64k	16-32k	32-48k
8+	16-32k	32-48k	0-16k	48-64k
9+	16-32k	48-64k	0-16k	32-48k
10+	32-48k	48-64k	0-16k	16-32k
	64163 row 1	64163 row 1	64163 row 1	64152/3/4
11	0-16k	16-32k	32-48k	48-64k
12	0-16k	32-48k	48-64k	16-32k
13	0-16k	16-32k	48-64k	32-48k
14+	16-32k	32-48k	48-64k	0-16k

\*in configurations 1,5,6,7 if there is only one 64152/3/4 memory board it can occupy either address space listed for 64152/3/4 memory boards.  
+in configurations 2-4,8-10, 14; there must be a block of memory located at 0-16k, so one of the 64152/3/4 memory boards must be set to location 0-16k.

## Model 64162 with Model 64163

A combination of 64162A and 64163A boards may be attached to a memory controller with one 64152/3/4 memory board.

The 8-pin DIP jumper on the 64162 and the 64163 must be in the position 0-64k. For the two single jumpers of the 64162, one must be in a position labeled with R1 and the other must be in a position labeled with R2. The single jumper must be in a position labeled R1 on the 64163. The address spaces of the single jumpers must not overlap each other.

The address space assigned to each board must not overlap the address space assigned to any of the other boards.

Table 2-4

	64162 row 1	64162 row 2	64163 row 1	64163 row 1
1	0-16k	16-32k	32-48k	48-64k
2	0-16k	16-32k	48-64k	32-48k
3	0-16k	48-64k	16-32k	32-48k
4	0-16k	48-64k	32-48k	16-32k
5	16-32k	48-64k	0-16k	32-48k
6	16-32k	48-64k	32-48k	0-16k
7	32-48k	16-32k	0-16k	48-64k
8	32-48k	16-32k	48-64k	0-16k
9	32-48k	48-64k	0-16k	16-32k
10	32-48k	48-64k	16-32k	0-16k
11	48-64k	16-32k	0-16k	32-48k
12	48-64k	16-32k	32-48k	0-16k

## 2-10. OPERATING ENVIRONMENT.

2-11. The 64161A/162A/163A may be operated in environments within the following limits:

Temperature.....0°C to 40°C  
 Humidity.....5 to 80% relative humidity at 40°C  
 Altitude.....4 600 M (15 000 ft)

It should be protected from temperature extremes which cause condensation within the instrument.

## 2-12. STORAGE AND SHIPMENT.

## 2-10. Environment.

2-13. The 64161A/162A/163A may be stored or shipped in environments within the following limits:

Temperature.....	-40° C to +75° C
Humidity.....	5 to 80% relative humidity
Altitude.....	15 000 m (50 000 ft)

## 2-14. Packaging.

2-15. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-17. Other Packaging. The following general instructions should be used for repacking with commercially available materials:

- a. Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center, attach tag indicating service required, return address, model number, and full serial number.)
- b. Use strong shipping container. A double-wall carton made of 350-pound test material is adequate.
- c. Use a layer of shock-absorbing material 70 to 100 mm (3- to 4-inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container.
- d. Seal shipping container securely.
- e. Mark shipping container FRAGILE to ensure careful handling.
- f. In any correspondence, refer to instrument by model number and full serial number.



SECTION III

OPERATION

Operation of the Model 64161A/162A/163A is beyond the scope of this manual. Emulation memory is an integral part of the emulation subsystem.



## SECTION IV

## PERFORMANCE VERIFICATION AND TROUBLESHOOTING

4-1. INTRODUCTION.

4-2. This section describes the Performance Verification for the Models 64161A/64162A/64163A Emulation Memory Boards.

4-3. This section is divided into two subsections: How to Run Performance Verification, and How to Interpret Performance Verification. Although the first subsection provides instructions on running several tests, only two tests will be described in the interpretation.

4-4. Use the following instructions to find the paragraphs which describe the Performance Verification of your system.

a. Be certain that your Memory subsystem is installed according to the directions in Section II.

b. For a system that is configured with a 64151A Memory Control Board.

    4-9. How to Run Performance Verification

    4-15. How to Interpret Performance Verification

c. For a system that is configured with a 64155 Memory Control

    4-12. How to Run Performance Verification with a mixture of 6416X and 6415X Memory Boards.

    4-12. How to Run Performance Verification with only 6416X memory boards.

    4-20. How to Interpret Performance Verification.

4-5. PERFORMANCE VERIFICATION.

4-6. The Performance Verification for the Models 64161A/64162A/64163A Emulation Memory is a subset of the 64000 system opt\_test Performance Verification. The opt\_test Performance Verification tests all possible option modules that can be configured within the expansion slots of the 64000 mainframe. Table 4-1 defines the softkey options available.

4-7. The scope of the Performance Verification procedures in this section is to provide the minimum amount of information necessary to completely verify the operation of the Emulation Memory Boards. Procedures for complete verification of the Emulation Memory subsystem are treated in the Service Manuals for the Emulation Memory Controllers and are not repeated here (although the user may be referred to these manuals while using the Performance Verification procedures).

Troubleshooting of the analyzer may be carried out to the component level, as described in this section, or to the module level. Although not specifically described in this section, module level repair simply involves replacement of the analyzer board if any of the performance verification tests fail. Module level repair is supported by the Hewlett-Packard Bluestripe exchange program.

Table 4-1. Option Test Softkey Definitions

<end>	Causes the test currently executing to abort and returns to the overview menu.
<cycle>	Causes the performance verification software to test each block of memory in turn, stepping to the next block as the testing of each block is completed.
<next_test>	Causes the inverse video bar to move highlighting the address range of the next block of emulation memory to be tested.
<start>	Causes the performance verification software to begin testing emulation memory in the address range currently highlighted by the inverse video bar.
<print>	Causes the performance verification test results (the area above the status line on the display) to be copied to the system printer, if one is connected.
<prev_test>	Causes the inverse video bar to highlight the address range immediately prior to the one currently highlighted. Used to select a desired block of memory for testing.
<img_test>	Causes image testing to be commenced on the block of memory whose address range is highlighted by the inverse video bar on the display. Used to check for address line problems.
<retn_test>	Causes the Performance Verification software to initiate the retention testing sequence, which is used to verify that the static RAM will hold a "0" or "1" for a certain amount of time.
<print>	Causes the test results above the status line to be copied to the system printer if one is connected.

- 4-8. HOW TO RUN PERFORMANCE VERIFICATION.
- 4-9. Memory PV With Model 64151A Memory Controller.  
(Configured in an 8-bit mode)
- 4-10. To run Performance Verification for the Emulation Memory Boards when a Model 64151A is being used as the emulation controller, use the following procedure:
  - a. Disconnect the target system.
  - b. Install the Emulation Memory subsystem in the HP 64000 development station. Refer to Section II of this manual for installation instructions. NOTE: FOR PERFORMANCE VERIFICATION--IF YOU ARE USING A COMBINATION OF 6416X AND 6415X MEMORY BOARDS ONE OF THE 6416X MEMORY BOARDS MUST BE INSTALLED NEXT TO THE 64151 MEMORY CONTROLLER.
  - c. With the operating system initialized and awaiting a command , manually type or use the softkey:

```
opt_test      RETURN
<slot #> (of 64151A)    RETURN
<next_test>  (until inverse video bar highlights the
                  Processor Control Test)
<start>
<cycle>
```

This will test all available blocks of emulation memory. NOTE: If emulation memory is unavailable in any particular address range, then "FFFF" will be displayed as the status; however, "# of fails" will be displayed as a "0".
  - d. If all available blocks of emulation memory test correctly, then the Emulation Memory Boards function correctly. It is then advisable to proceed with the remainder of the Emulation Memory subsystem testing as outlined in the appropriate Emulation Memory Controller Service Manual.

4-11. Memory Performance Verification with Model 64155A Memory Controller.

4-12. The following instructions cover Performance Verification for the Memory Controller and the Memory Boards. Only the "Memory Test" is described in this manual (paragraph 4-20). If the other tests fail, please refer to the 64155A Memory Control Service Manual. To run Performance Verification for the Emulation Memory Boards when a Model 64155A is being used as the Emulation Memory Controller, proceed as follows:

Running PV with a mixture of 6415X and 6416X memory boards.

- a. Disconnect the target system.
- b. Install the Emulation Memory subsystem in the HP64000 development station. Refer to Section II of this manual for installation instructions. NOTE: WHEN USING BOTH 6416X SERIES MEMORY AND 6415X MEMORY IN AN EMULATION SUBSYSTEM THE 6416X MEMORY BOARDS MUST NOT BE INSTALLED IN AN OPTION SLOT ADJACENT TO THE MODEL 64155 MEMORY CONTROLLER.

Running PV with 6416X Memory Boards only.

- a. Disconnect the target system.
- b. Install the Emulation Memory subsystem in the HP64000 development station. Refer to Section II of this manual for installation instructions. NOTE: FOR PERFORMANCE VERIFICATION--THE 6416X MEMORY BOARD MUST BE INSTALLED IN A SLOT ADJACENT TO THE MEMORY CONTROLLER.

The following steps are identical for any memory board configuration with the 64155A Memory Controller.

- c. With the operating system initialized and awaiting a command, manually type or use the softkey:

```
opt_test    RETURN  
<slot #> (for 64155A) RETURN  
select the memory range *
```

\*select the maximum memory range in "K words" of the memory boards being tested. For example, if the highest memory range of the boards being tested is 256K-320K (as indicated by the jumper located in XE1,XE2,XE3,XE4) depress the softkey corresponding to that range. When using a mixture of 6416X and 6415X memory always select 0-64k. It is not necessary to RETURN.

```
<next_test> (until inverse video bar highlights the  
"System->Board Access Test")  
<select>
```

This will display the "System->Board Access Test"

```
<cycle>
```

Cycle through the test several times. If no failures occur, press the <end> softkey which will return the display to the Memory Performance Verification overview menu.

```
<next_test> (until inverse video bar highlights the  
"Memory Mapper" test)  
<select>
```

This will display the "Memory Mapper" test.

```
<cycle>
```

Cycle through the Memory Mapper test sequence several times. If no failures occur, press the <end> softkey to return to the Memory PV overview menu.

```
<next_test> (until inverst video bar highlights "Memory  
Control" test)  
<select>
```

This will display the "Memory Control" test.

```
<cycle>
```

Cycle through the "Memory Control" test several times. If no failures occur, press the <end> softkey to return to the Memory PV overview menu.

```
<next_test> (until inverse video bar highlights "Memory  
Test")
```

```
<select>
```

This will display the "Memory Test"

```
<cycle>
```

NOTE: if emulation memory is unavailable in any particular address range, then "FFFF" will be displayed as the status; however, "# of fails" will be displayed as a "0".

Allow the "Memory Test" to cycle through the test several times. This will test all available blocks of memory up to the limit specified when the address range was selected. If desired, each individual block may also be tested for possible imaging problems and data retention failures by moving the highlighted inverse video bar to the desired block of memory with the <next\_test> and <prev\_test> keys, then pressing the <img\_test> or <retn\_test> softkeys to perform the necessary tests.

If all available blocks of memory test with no failures, then the Emulation Memory Boards work correctly. It is advisable to proceed with the remainder of the Emulation Memory Subsystem testing as outlined in the Emulation Memory Controller Service Manual.

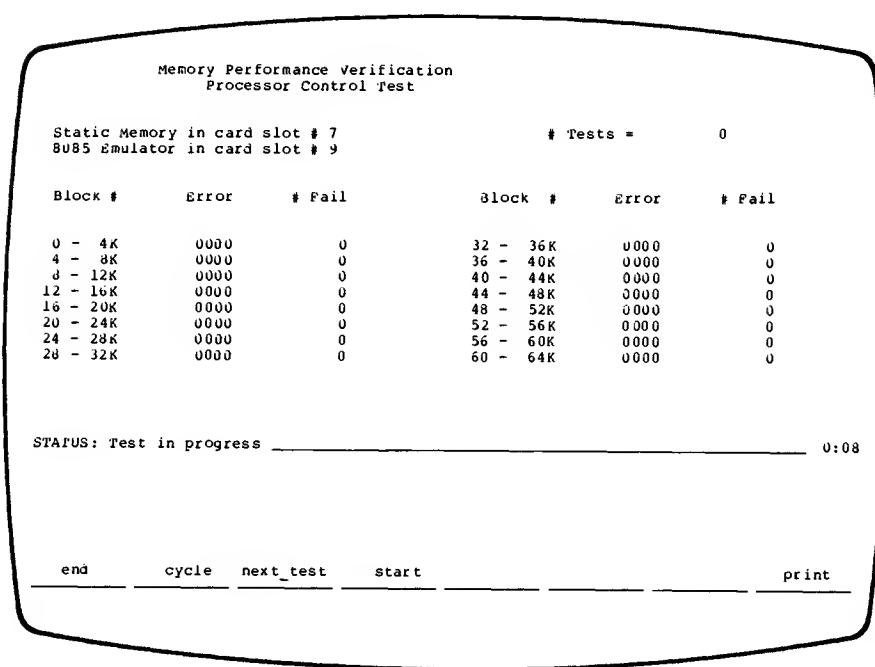


Figure 4-1. Processor Control Test Display.

**4-13. HOW TO INTERPRET PERFORMANCE VERIFICATION.**

4-14. Theory of Operation for the Memory Performance Verification is treated on a software test/results interpretation basis only; and is treated separately for Emulation Memory Boards driven by the 64151A and 64155 Emulation Memory Controllers.

**4-15. Model 64151A/Emulation Memory--Processor Control Test.**

4-16. Purpose--verifies that all the memory cells in a selected row can be written with random data patterns and that the data written can be read back correctly.

4-17. How--The Mainframe CPU initializes the Memory Controller Board and programs the memory mapper. Random data is then written to the first cell in the selected row of memory (a row is 16K deep by 16 bits wide). The data just written to this cell is immediately read back and compared with that written. The process then continues with each cell in turn. At the end of this process, the entire row of memory is read back and checked to verify that no RAM cells were overwritten by an address imaging problem (image testing is described further in the following paragraph). Errors are logged in a cumulative fashion to the status display.

4-18. Results--if no failures occur in the tested block of memory, the # fails indicator will be left at "0" and the "Error" message will display 0000 (hexadecimal), opposite the address range information for the selected block. However, if failures do occur in the tested block of memory, the # fails indicator will be incremented for each time that the test is run, and the "Error" message of 0000H will be replaced with a hexadecimal status message that indicates the position of the failing data bits. A "one" is placed in the status message for every data bit that is failing. To decode the status message, use the Table 4-1.

4-19. Because the memory is tested in 4K blocks and each IC is 16k long, imaging of 4K block sections is tested. The upper two address bits (A13, A12) are represented in the line "Image Errors" X1X2. If X1 is a "1" A13 is bad, if X0 is "1" A12 is bad.

**Performance Verification Model 64161A/162A/163A**

**Table 4-2. Data Failure Status Decoding**

XXXX	=	0000	0000	0000	0000		
-----	-----	-----	---	1	D0		
-----	-----	-----	--	1-	D1		
-----	-----	-----	-	1--	D2		
-----	-----	-----	1	--	D3		
-----	-----	---	1	--	D4		
-----	-----	--	1-	--	D5		
-----	-----	-	1--	--	D6		
-----	-----	1	--	--	D7		
-----	---	1	--	--	D8		
-----	--	1-	--	--	D9		
-----	-	1--	--	--	D10		
-----	1	--	--	--	D11		
---	1	--	--	--	D12		
--	1-	--	--	--	D13		
-	1--	--	--	--	D14		
1	--	--	--	--	D15		

**Table 4-3.**

	ERROR CODE	I	C	O	S
	BINARY	0 0 0 1	1 1 0 0	0 0 0 0	1 0 0 1
1	0-36 16-32 32-48 48-64	U7P U7Q U7N U7M	U7L U7K U7J U7I	U7H U7G U7F U7E	U7D U7C U7B U7A
2	16-32 48-64	U6P U6Q U6N U6M	U6L U6K U6J U6I	U6H U6G U6F U6E	U6D U6C U6B U6A
3	32-48	U5P U5Q U5N U5M	U5L U5K U5J U5I	U5H U5G U5F U5E	U5D U5C U5B U5A
4	48-64	U4P U4Q U4N U4M	U4L U4K U4J U4I	U4H U4G U4F U4E	U4D U4C U4B U4A
ROW ADDRESS RANGE	DATA BITS	D15 D14 D13 D12	D11 D10 D9 D8	D7 D6 D5 D4	D3 D2 D1 D0
DATA BUFFERS	U3N	U3H	U3L	U3K	
	UPPER BYTE		LOWER BYTE		

## 4-20. Memory Test with the 64155 Controller.

4-21. Purpose--Verifies that all memory cells in the selected row can be written with random data patterns and that the data written can be read back correctly. If desired, the test can also verify that no address imaging problems exist, and that the RAM cells can retain data for a certain amount of time.

## 4-22. What--Each possible test is described in the paragraphs below.

- a. Memory Test. The Mainframe CPU initializes the Memory Controller Board and programs the memory mapper. Random data is then written to the first cell in the selected row of memory (a row is 16K deep by 16 bits wide). The data just written to this cell is immediately read back and compared with that written. The process then continues with each cell in turn. At the end of this process, the entire row of memory is read back and checked to verify that no RAM cells were overwritten by an address imaging problem (image testing is described further in the following paragraph). Errors are logged in a cumulative fashion to the status display.
- b. Image Test. If the <img\_test> softkey is pressed, the Performance Verification software initiates image testing of the selected row of RAM. This testing checks for open or shorted address lines. The reasons for and process of image testing are best explained by examining the case of an 8 X 1 RAM device.

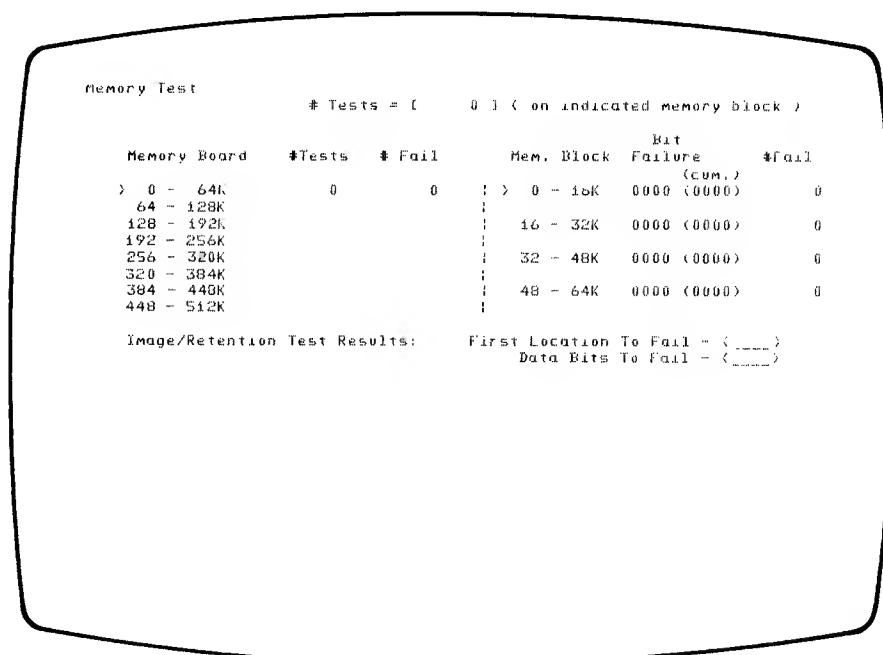


Figure 4-2. Memory Test Display

Suppose we proceed to image test the RAM, and there are no address line problems or other problems associated with the RAM. We would proceed with image testing the Most Significant address line of the RAM by pulling it low, then high, while incrementing the least significant address bits. Note that at the same time that the most significant address bit is changed, we also change the data written into the RAM from a "0" to a "1". The loaded RAM appears as follows:

8 x 1 RAM	
ADDRESS	DATA
000	0
001	0
010	0
011	0
100	1
101	1
110	1
111	1

If the data is now read back, and there are no address line problems, then the correct data is interpreted as coming from each location.

Now let's examine the same situation, but with a different twist. We're still testing the most significant address bit for an imaging problem, but this time, it's not making contact with the address input of the RAM because of a bad socket (or for whatever other reason). Note: it is important to remember that unconnected inputs in TTL and MOS generally float to the high state. When we try to load the first four locations, here's what happens:

8 x 1 RAM	
ADDRESS	DATA
000	x
001	x
010	x
011	x
100	0
101	0
110	0
111	0

No data is loaded into the first four locations because the most significant address line could not be pulled low.

Instead, the 0's are loaded into the next four locations because the most significant address bit floats to the high state. When the next four locations are loaded the results are as follows:

#### 8 x 1 RAM

ADDRESS	DATA
000	x
001	x
010	x
011	x
100	1
101	1
110	1
111	1

Notice that the 1's are loaded into the correct locations, because the MSB address line has floated high, however, they overwrite the 0's that were written earlier.

What happens now? When the performance verification software attempts to read the RAM back, it will begin by attempting to read locations 000-011, at which it tried to store 0's. However, since the most significant address line is open, it reads back the 1's that were stored at 1000-1111--which is the "image" of the lower address range. The 1's were not the correct response; therefore, an error message is displayed for locations 000-011. To troubleshoot this type of failure, the technician only needs to determine which address line would have to be open to cause one set of addresses to fail and another set of addresses to pass.

- c. Retention Test. This test checks the ability of each RAM cell to hold data for a defined length of time. To do this, the mainframe CPU writes 0's to every location in memory, waits 60 seconds, then reads every location back. The process is repeated by writing 1's to all locations, then reading the locations back after approximately 60 seconds. As soon as a failure is detected in either test, the testing is aborted.

#### 4-23. Results.

- a. Memory Test. If no data failures are encountered during testing of the selected 64K address range, then the "#FAIL" status is left at 0. This information is displayed on the left hand side of the screen. If failures occur during the course of the test, then "# FAIL" status is incremented once for every time the test is run. The right side of the display divides each 64K memory block

into four 16K blocks which correspond to the four rows of memory chips. The "BIT FAILURE" status will display a hexadecimal status message indicating the position of the failing bits. To interpret the status message refer to Table 4-x.

- b. Image Test. If no failures are found during the image testing, then the "First Location to Fail" status and the "Data Bits to Fail" status will be left blank. These status lines are located directly across from the "Image/Retention Test Results" line on the display. If a failure is encountered during the course of the image testing, then the blank "First Location to Fail" status will be replaced by a hexadecimal status message which shows the address of the first failure location; and the "Data Bits to Fail" status will be replaced by a hexadecimal status message which shows the data bits which failed at that locations. For information on decoding the data status, refer to Table 4-x.
- c. Retention Test. If no failures are found during the retention testing, then the "First Location to Fail" status and the "Data Bits to Fail" status will be left blank. These status lines are located directly across from the "Image/Retention Test Results" line on the display. However, if a failure is encountered during the retention testing, then the test aborts. The blank "First Location to Fail" status will be replaced with a hexadecimal status message which shows the address location of the memory cell that changed during the lag time between the write and the read; the "Data Bits to Fail" status will be replaced with a hexadecimal status message which shows the data RAM's that were unable to retain the information for the required length of time. For information on decoding the data status, refer to Table 4-1.

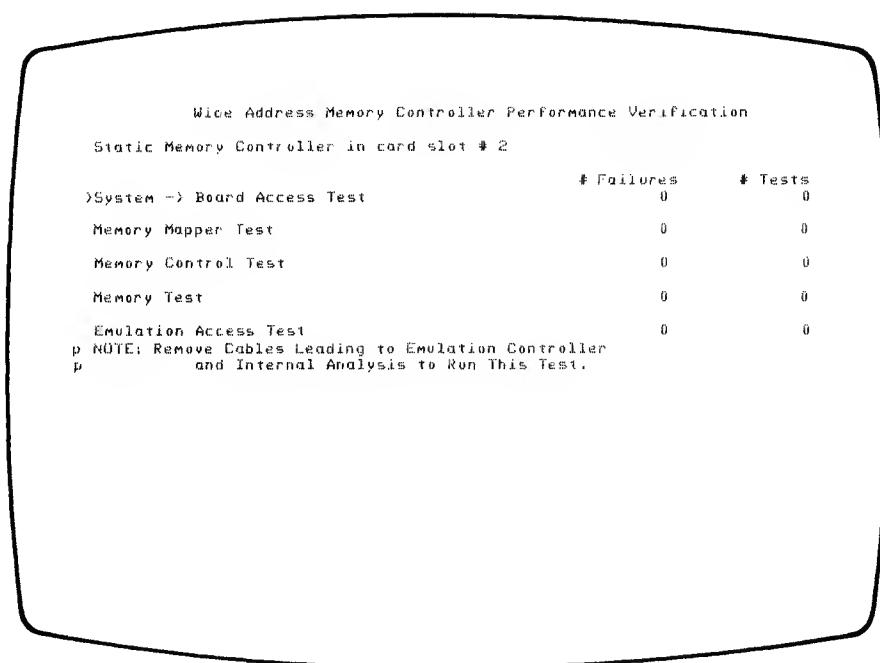


Figure 4-3. Performance Verification Overview Display

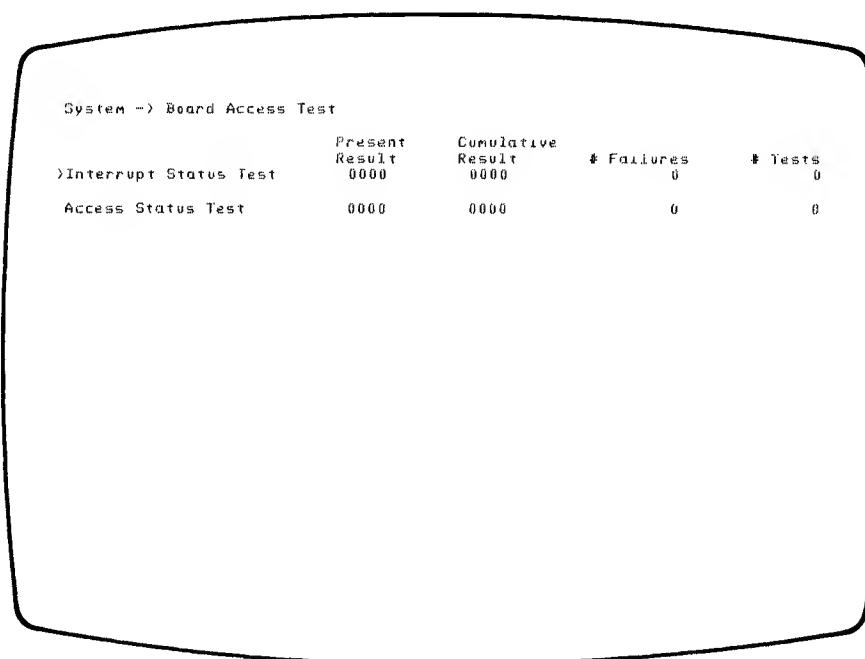


Figure 4-4. System-Board Access Test Display

Memory Mapper Test		# Failures	# Tests
> 2 K word Block Size		0	0
128 Word Block Size		0	0
	Present Bit Failures	Cumulative Bit Failures	
System Data Bus	0000 0000 0000	0000 (supply shorts or opens) 0000 (word mode) 0000 (byte mode)	
System Address Bus	0000 0000	0000 (walking ones) 0000 (walking zeroes)	
Mapper Image Test	0000 0000	0000 (walking ones) 0000 (walking zeroes)	
System Address Register	0000 0000	0000 (walking ones) 0000 (walking zeroes)	

Figure 4-5. Memory Mapper Test Display

Memory Control Test		# Failures	# Tests
>Block Size Select Option Test		0	0
Real Time Access Option Test		0	0
Allow Writes to ROM Option Test		0	0
Memory Controller Interrupt Option Test		0	0

Figure 4-6. Memory Control Test Display

Emulation Access Test		* Failures	* Tests
> 2 K word block size		0	0
i28 word block size		0	0
Timing Test Results	Present Bit Failures	Cumulative Bit Failures	
	0000	0000	
Status Test Results	0000	0000	
Emulation Data Bus	0000	0000	(supply shorts or opens)
	0000	0000	(word mode)
	0000	0000	(byte mode)
Emulation Address Bus	0000 (mapped) (bits)	0000 (unmapped) (bits)	0000 (walking ones) 0000 (unmapped) (bits)
			(walking zeroes)

Figure 4-7. Emulation Access Test Display.



SECTION V

ADJUSTMENTS

Models 64161A/162A/163A Emulation Memory require no adjustments.



SECTION VI  
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains names and addresses that correspond to the manufacturers' code numbers.

6-3. ABBREVIATIONS.

6-4. Table 6-1 lists abbreviations used in the parts list, the schematics and throughout the manual. In some cases, two forms of the abbreviations are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-5. REPLACEABLE PARTS LIST.

6-6. Table 6-2 is the list of replaceable parts and is organized as follows:

- a. Electrical assemblies and their components in alphanumerical order by reference designation.
- b. Chassis-mounted parts in alphanumerical order by reference designation.
- c. Miscellaneous parts.
- d. Illustrated parts breakdowns, if appropriate.

The information given for each part consists of the following:

- a. The Hewlett-Packard part number.
- b. The total quantity (Qty) in the instrument.
- c. The description of the part.
- d. A typical manufacturer of the part in a five-digit code.
- e. The manufacturer's number for the part.

The total quantity for each part is given only once--at the first appearance of the part number in the list.

## 6-7. ORDERING INFORMATION.

6-8. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard Office.

## 6-10. SPARE PARTS KIT.

6-11. At this time no Spare Parts Kit is available for this instrument

## 6-12. DIRECT MAIL ORDER SYSTEM.

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

- a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.
- b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when orders require billing and invoicing).
- c. Prepaid transportation (there is a small handling charge for each order).
- d. No invoices--to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information is available through your local HP office. Addresses and phone numbers are located at the back of this manual.

## 6-15. EXCHANGE ASSEMBLIES

6-16. Exchange assemblies are available from the HP Corporate Parts center on a trade in bases. These exchange assemblies, are listed in Table 6-2.

Table 6-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS							
<b>A</b>	= assembly	<b>F</b>	= fuse	<b>MP</b>	= mechanical part	<b>U</b>	= integrated circuit
<b>B</b>	= motor	<b>FL</b>	= filter	<b>P</b>	= plug	<b>V</b>	= vacuum, tube, neon
<b>BT</b>	= battery	<b>IC</b>	= intagrated circuit	<b>O</b>	= transistor	<b>VR</b>	= bulb, photocell, etc
<b>C</b>	= capacitor	<b>J</b>	= jack	<b>R</b>	= resistor	<b>W</b>	= voltage regulator
<b>CP</b>	= coupler	<b>K</b>	= relay	<b>RT</b>	= thermistor	<b>X</b>	= cable
<b>CR</b>	= diode	<b>L</b>	= inductor	<b>S</b>	= switch	<b>Y</b>	= socket
<b>DL</b>	= delay line	<b>LS</b>	= loud speaker	<b>T</b>	= transformer	<b>Z</b>	= crystal
<b>DS</b>	= device signaling (lamp)	<b>M</b>	= meter	<b>TB</b>	= terminal board		= tuned cavity network
<b>E</b>	= misc electronic part	<b>MK</b>	= microphone	<b>TP</b>	= test point		
ABBREVIATIONS							
<b>A</b>	= amperes	<b>H</b>	= henries	<b>N/O</b>	= normally open	<b>RMO</b>	= rack mount only
<b>AFC</b>	= automatic frequency control	<b>HDW</b>	= hardware	<b>NOM</b>	= nominal	<b>RMS</b>	= root-mean square
<b>AMPL</b>	= amplifier	<b>HEX</b>	= hexagonal	<b>NPO</b>	= negative positive zero (zero temperature coefficient)	<b>RWV</b>	= reverse working voltage
<b>BFO</b>	= beat frequency oscillator	<b>HG</b>	= mercury	<b>NPN</b>	= negative-positive-negative	<b>S-B</b>	= slow-blow
<b>BE CU</b>	= beryllium copper	<b>HR</b>	= hours)	<b>NRFR</b>	= not recommended for field replacement	<b>SCR</b>	= screw
<b>BH</b>	= binder head	<b>HZ</b>	= hertz	<b>NSR</b>	= not separately replaceable	<b>SE</b>	= selenium
<b>BP</b>	= bandpass	<b>IF</b>	= intermediate freq	<b>OBD</b>	= order by description	<b>SECT</b>	= sectional
<b>BRS</b>	= brass	<b>IMPG</b>	= impregnated	<b>OH</b>	= oval head	<b>SEMICON</b>	= semiconductor
<b>BWO</b>	= backward wave oscillator	<b>INCD</b>	= incandescent	<b>OX</b>	= oxide	<b>SI</b>	= silicon
<b>CCW</b>	= counter-clockwise	<b>INCL</b>	= includes(s)			<b>SIL</b>	= silver
<b>CER</b>	= ceramic	<b>INS</b>	= insulation(ed)			<b>SL</b>	= slide
<b>CMO</b>	= cabinet mount only	<b>INT</b>	= internal			<b>SPG</b>	= spring
<b>COEF</b>	= coefficient					<b>SPL</b>	= special
<b>COM</b>	= common	<b>K</b>	= kilo=1000			<b>SST</b>	= stainless steel
<b>COMP</b>	= composition	<b>LH</b>	= left hand			<b>SR</b>	= split ring
<b>COMPL</b>	= complete	<b>LIN</b>	= linear taper	<b>P</b>	= peak	<b>STL</b>	= steel
<b>CONN</b>	= connector	<b>LK WASH</b>	= lock washar	<b>PC</b>	= printed circuit		
<b>CP</b>	= cadmium plate	<b>LOG</b>	= logarithmic taper	<b>PF</b>	= picofarads= 10 <sup>-12</sup> farads	<b>TA</b>	= tantalum
<b>CRT</b>	= cathoda-ray tube	<b>LPF</b>	= low pass filter	<b>PH BRZ</b>	= phosphor bronze	<b>TD</b>	= time delay
<b>CW</b>	= clockwise			<b>PHL</b>	= phillips	<b>TGL</b>	= toggle
<b>DEPC</b>	= deposited carbon	<b>M</b>	= milli=10 <sup>-3</sup>	<b>PIV</b>	= peak inverse voltage	<b>THD</b>	= thread
<b>DR</b>	= drive	<b>MEG</b>	= meg=10 <sup>6</sup>	<b>PNP</b>	= positive-negative-positive	<b>TI</b>	= titanium
<b>ELECT</b>	= electrolytic	<b>MET FLM</b>	= metal film	<b>P/O</b>	= part of	<b>TOL</b>	= tolerance
<b>ENCAP</b>	= encapsulated	<b>MET OX</b>	= metallic oxide	<b>POLY</b>	= polystyrene	<b>TRIM</b>	= trimmer
<b>EXT</b>	= external	<b>MFR</b>	= manufacturer	<b>PORC</b>	= porcelain	<b>TWT</b>	= traveling wave tube
<b>F</b>	= farads	<b>MHZ</b>	= mega hertz	<b>POS</b>	= position(s)	<b>U</b>	= micro=10 <sup>-6</sup>
<b>FH</b>	= flat head	<b>MINAT</b>	= miniature	<b>POT</b>	= potentiometer	<b>VAR</b>	= variable
<b>FIL H</b>	= fillister head	<b>MOM</b>	= momentary	<b>PP</b>	= peak-to-peak	<b>VDCW</b>	= dc working volts
<b>FXD</b>	= fixed	<b>MOS</b>	= metal oxide substrate	<b>PT</b>	= point	<b>W/</b>	= with
		<b>MTG</b>	= mounting	<b>PWV</b>	= peak working voltage	<b>W</b>	= watts
		<b>MY</b>	= "mylar"			<b>WIV</b>	= working inverse voltage
<b>G</b>	= giga (10 <sup>9</sup> )	<b>N</b>	= nano (10 <sup>-9</sup> )	<b>RECT</b>	= rectifier	<b>WW</b>	= wirewound
<b>GE</b>	= germanium	<b>N/C</b>	= normally closed	<b>RF</b>	= radio frequency	<b>W/O</b>	= without
<b>GL</b>	= glass	<b>NE</b>	= neon	<b>RH</b>	= round haad or right hand		
<b>GRD</b>	= ground(ed)	<b>NI PL</b>	= nickel plate				

Table 6-2. Replaceable Parts List

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	64161-66501	8	1	BOARD ASSEMBLY-MEMORY 128K-NEW	28480	64161-66501
A1	64161-66501			128KB EMUL. RAM PCA-EXCHANGE	28480	64161-69501
A1	64161-66501			64KB EMUL. RAM PCA-EXCHANGE	28480	64161-69501
A1	64161-66501			32KB EMUL. RAM PCA-EXCHANGE	28480	64161-69501
C1-C2	0160-5246	6	80	CAPACITOR-FXD .1 UF +80-20% 50 VDC CER	28480	0160-5246
C3-C4	0180-0229	4	4	CAPACITOR-FXD .22 UF +-10% 15 VDC TA	28480	0180-0229
C5-C62	0160-5246	6		CAPACITOR-FXD .1 UF +80-20% 50 VDC CER	28480	0160-5246
TP1-TP3	0360-0535	0	3	TERM TEST POINT	28480	0360-0535
R1-R2	0757-0280	3	6	RESISTOR 1K 1% .125W F TC=0+-100	28480	0757-0280
R3-R4	0698-3432	7	2	RESISTOR 26.1 1% .125W F TC=0+-100	28480	0698-3432
RS	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	28480	0757-0280
R6-R9	0757-0399	5	4	RESISTOR 82.5 1% .125W F TC=0+-100	28480	0757-0399
R10-R12	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	28480	0757-0280
XE1-XE5	1200-0607	0	5	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
E1-E2	1251-4398	1	2	SHUNT DIP 4 POSITION; DUAL INLINE PKG	28480	1251-4398
RP1	1810-0275	1	1	NETWORK-RES 10-SIP 1.0K OHM X 9	28480	1810-0175
UR3C-UR3F	1810-0600	6	4	NETWORK-RES 16-DIP 40.0 OHM X 8	28480	1810-0600
U2C	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U2D	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U2E	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U2F	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U2G	1820-2861	5	4	IC DCDR TTL F 3-T0-8 LINE 3-INP	07263	74F138PC
U2H	1820-2861	5		IC DCDR TTL F 3-T0-8 LINE 3-INP	07263	74F138PC
U2I	1820-2861	5		IC DCDR TTL F 3-T0-8 LINE 3-INP	07263	74F138PC
U2J	1820-2861	5		IC DCDR TTL F 3-T0-8 LINE 3-INP	07263	74F138PC
U2K	1820-2690	9	1	IC GATE TTL F OR QUAD 2-INP	07263	74F32
U2L	1820-1198	0	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
U2M	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
U3G	1820-1204	9	1	IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20
U3J	1820-2684	1	1	IC GATE TTL F NAND QUAD 2-INP	07263	74F00
U3K	1820-1633	8	8	IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U3L	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U3M	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U3N	1820-1633	8		IC BFR TTL S INV OCTL 1-INP	01295	SN74S240N
U4A-U4P	1818-1969	8	64	IC CMOS F16384 (16K) STAT RAM 70NS	S4013	HM6167P
USA-U5P	1818-1969	8		IC CMOS F16384 (16K) STAT RAM 70NS	S4013	HM6167P
U6A-U6P	1818-1969	8		IC CMOS F16384 (16K) STAT RAM 70NS	S4013	HM6167P
U7A-U7P	1818-1969	8		IC CMOS F16384 (16K) STAT RAM 70NS	S4013	HM6167P
E3,4	1258-0182	7	2	CONNRP IM PLUG	28480	1258-0182

See introduction to this section for ordering information

Table 6-3. List of Manufacturers' Codes

Mfr No.	Manufacturer Name	Address	Zip Code
00000 01295 07263 S4013	ANY SATISFACTORY SUPPLIER TEXAS INSTR INC SEMICOND CMPNT DIV FAIRCHILD SEMICONDUCTOR DIV HITACHI	DALLAS TX MOUNTAIN VIEW CA TOKYO JP	75222 94042

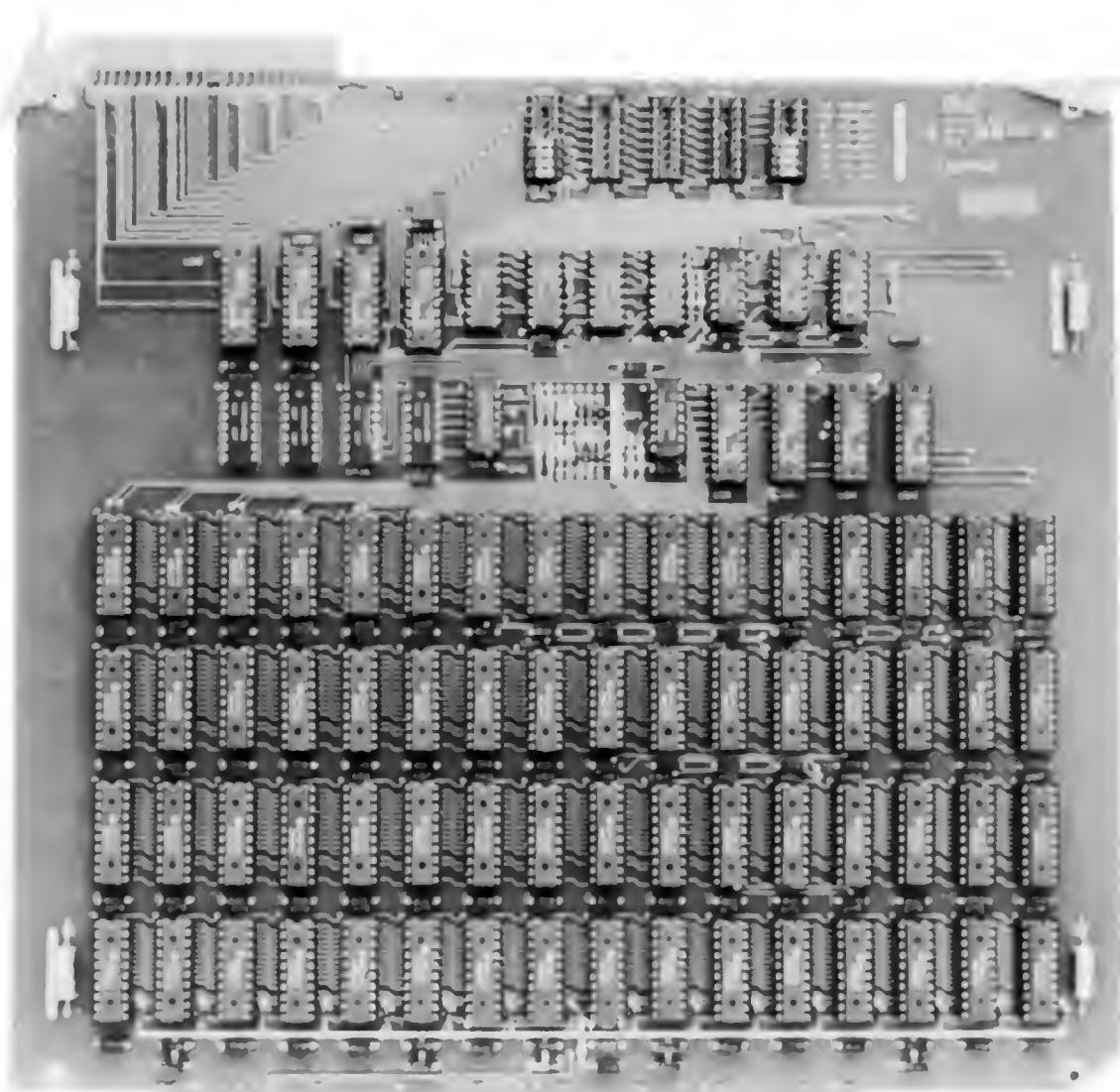


Figure 6-1. Replaceable Parts Locator

SECTION VII

MANUAL CHANGES

This section normally contains information for backdating this manual for models with repair numbers prior to the one shown on the title page. Because this edition includes the information for the first repair number there is no backdating material.

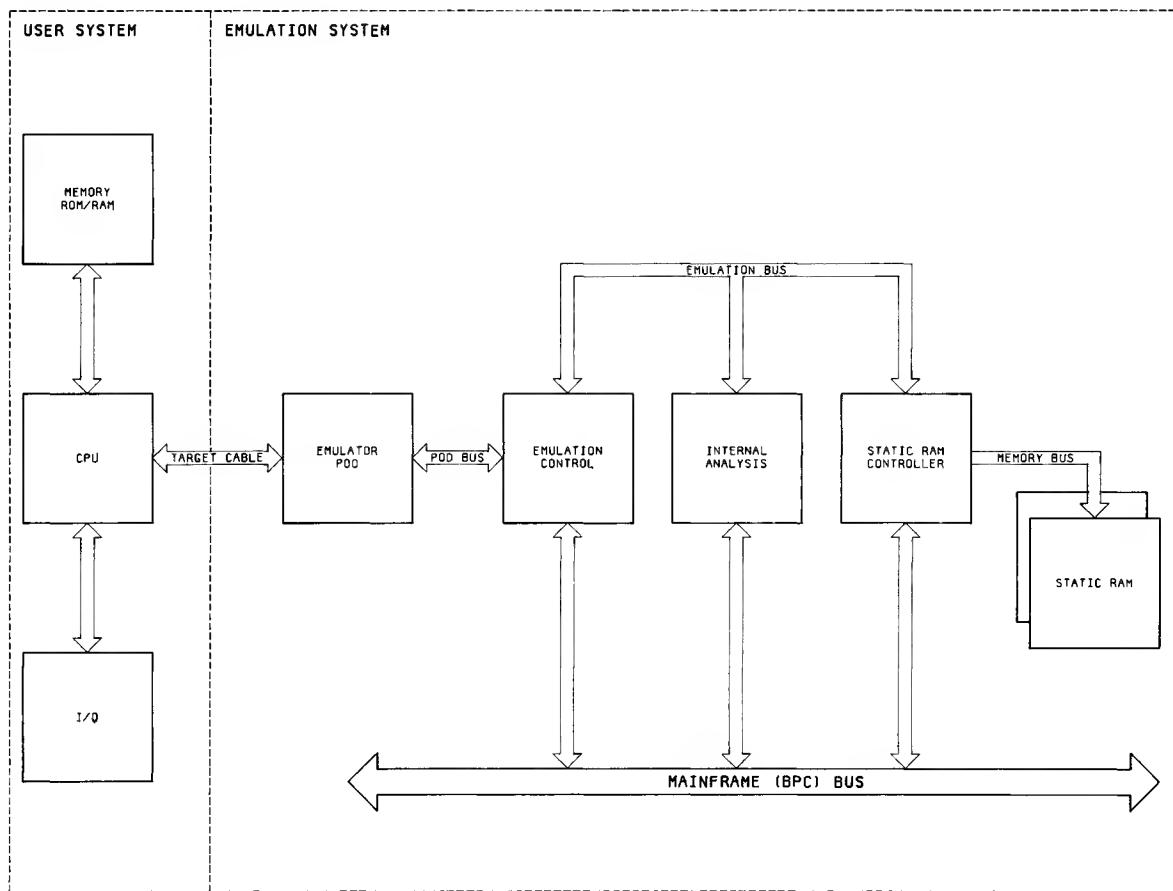


Figure 8-1. Emulation Subsystem

## SECTION VIII

## THEORY AND SCHEMATICS

## 8-1. INTRODUCTION.

8-2. This section contains block and component level theory and schematics for the 64161A, 64162A and 64163A Emulation Memories.

8-3. LOGIC CONVENTIONS. The positive logic convention is used for logic variables and circuits within the 64161A/162A/163A. Positive logic defines a "1" as the more positive voltage (high) and a "0" as the more negative logic (low).

## 8-4. LOGIC LEVELS. TTL high- 2.0 low 0.8

8-5. POWER SUPPLIES. The mainframe supplies +5 volts and +12 volts to the emulation memory for operating power.

8-6. The block diagram, schematic, component locator, and other service information are provided in foldout service sheets to help in servicing the emulation memory.

## 8-7. THEORY.

## 8-8. OVERVIEW.

8-9. The 64000 microprocessor emulation systems, illustrated in figure 1-2, allow software designers to develop and debug software modules for specific microprocessors. The emulation plug replaces the microprocessor physically in the target system permitting hardware in the emulation system to simulate the functions of the target microprocessor while driving target system hardware with the software being developed.

8-10. The emulation memory can be used to duplicate the target system memory. Address space can be allocated to target system EAM, target system ROM, emulation RAM, and emulation ROM, and illegal address space.

8-11. The Memory Controller is the interface between the emulation memory, the installed Emulator, and the 64000 operating system. This option also maps the users address received via the emulation bus into available emulation memory. The mapping process is performed by mapper RAM's which reside on the Memory Controller. A read/write operation to emulation memory is performed via the memory bus.

8-12. The mapper RAM's also output signals which specify what type of memory the given block of emulation memory is supposed simulate (RAM, ROM, or GUARDED Memory), or whether a given address is

to be regarded as user address space and not acted upon. The Memory Controller will also signal the analysis equipment and halt emulation when a GUARDED memory access is attempted and, if optionally configured, when a write to ROM is attempted.

8-13. When the 64161A/162A/163A Memory Boards are installed each Memory Board is hardwired with DIP jumpers to enable a specific memory range so that only one Memory Board will respond to each address.

8-14. The hardware on the Memory Boards simulates address decoder circuitry and some type of memory space which has been defined on the Memory Controller.

#### 8-15. BLOCK THEORY.

8-16. The Model 64161A/162A/163A Block Diagram illustrates the three functional blocks of the memory board: decoder circuitry, address and data buffers, and the memory array. The decoder circuitry specifies the address range of the memory board, decodes the memory rows selected, produces a read enable signal and configures the 64162A and 64163A memory mapping to be compatible with 64152A, 64153A and 64154A memory boards. The address and data buffers drive the signals which are direct inputs to the RAM array.

8-17. U2G through U2J, ROW SELECT DECODERS, demultiplex the upper five address lines A14-A18 to select row numbers of the memory to be accessed. An 8-pin DIP jumper plugged into one of the sockets XE1-XE4 specifies the 64K word addressable range of the memory board.

8-18. The ADDRESS RANGE SELECT JUMPER, XE5 configures the 64162A and 64163A to be compatible with the 64152A, 64153A and 64154A memory boards. If the 64161A, 64162A, or 64163A are not combined with other memory boards an 8-pin DIP jumper should be plugged into the lower half of the socket. Please refer to Section II for complete information on the memory mapping configurations which are possible.

8-19. The network composed of R6-R9 and CR1,2,6,7 deselects the RAM array when the circuitry is powered up. Pulling the circuitry to +12 volts through RP1 brings the voltage in Row 1-4 up quickly when the system is powered on, and the zener diodes CR1,2,6,7 clamp the voltage at approximately +5 volts. This deselection process prevents the RAM array from drawing a large surge of current by putting the RAMs on their low power standby mode.

8-20. Whenever the ROW SELECT DECODERS pull one of the ROWs 1-4 low, the BOARD SELECT GATE, U3GB, produces HRDEN. The READ ENABLE GATE, U3JA, gates LWRT (high) and HRDEN to produce LRD.

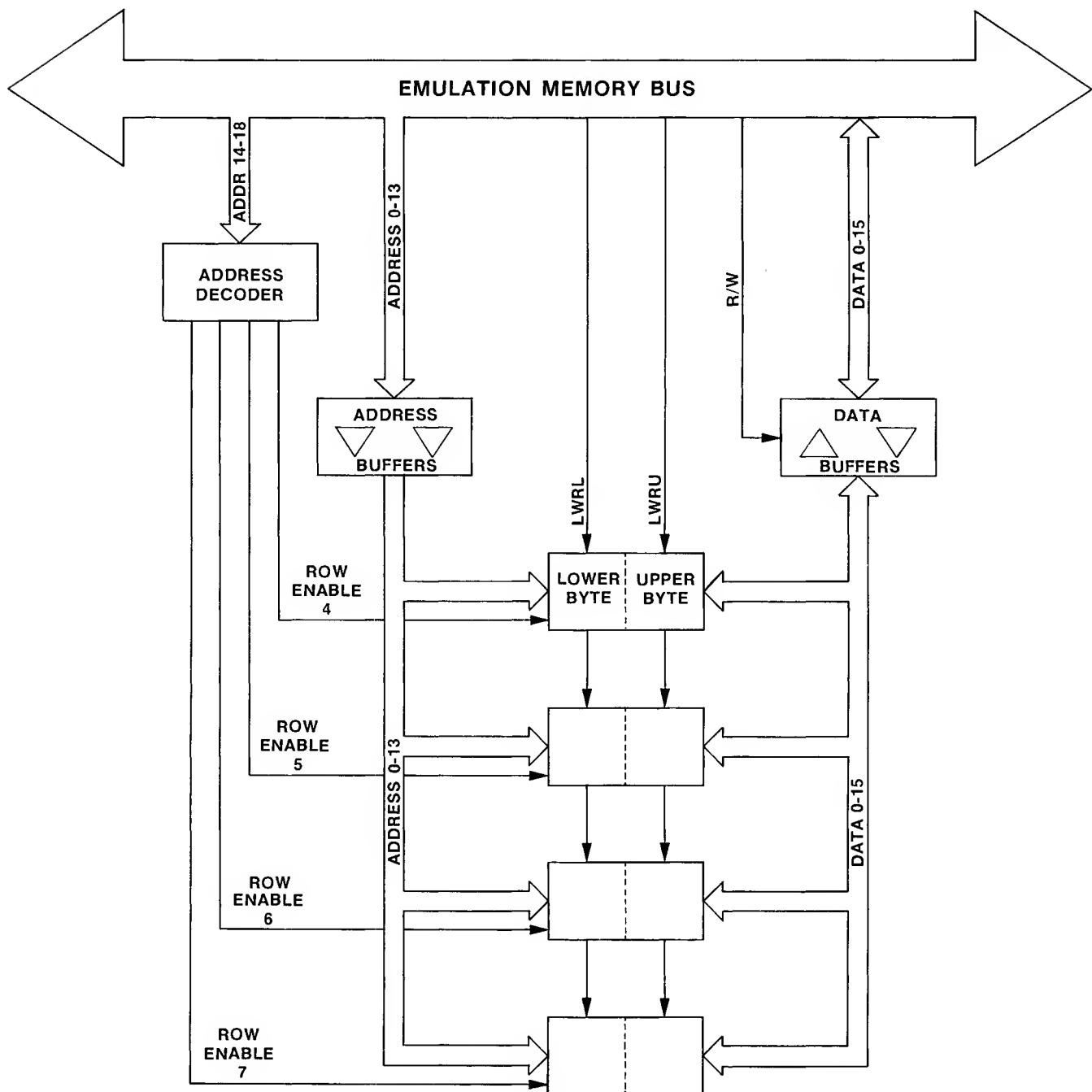


Figure 8-2. Emulation Memory Block Diagram.

8-21. From the Memory Controller on the Emulation Memory Bus the Memory Board receives 19 address lines, 16 data lines and three control lines. The 16 data lines and the lower 14 address lines are buffered through the DATA BUFFERS, U3K-U3N, and the ADDRESS BUFFERS, U2C-U2F, then used as direct inputs to the RAM array. CR11-26 and R12 form a pullup network for the data inputs to the RAMs. This guarantees that the proper voltage levels are applied to the RAM inputs during a write cycle so that correct data is written. LWRT is a directional control for the DATA BUFFERS. LWRL and LWRU enable the lower and/or upper bytes of the RAM array.

8-22. The RAM array consists of an upper byte and a lower byte, which may also be accessed as a single 16-bit word. The Hitachi 6167 16k x 1-bit static Rams feature 70 nsec access time, low power standby mode, low power operation and asynchronous operation.

8-23. Power and ground connections and an 8-bit I.D. signal are the only connections between the memory board and the mainframe. The codes produced by the EMULATION MEMORY BOARD ID CIRCUITRY are listed in Table 8-1.

Table 8-1. Memory Board ID Code.

CODE	# OF ROWS LOADED
01F8	4
01F9	2
01FA	1

## 8-24. MNEMONICS.

8-25. Signals in the 64161A/162A/163A/162A/163A have been assigned mnemonics which describe the active state and function of the signal line. A prefix letter (H, L, P, OR N) indicates the active state of the signal and the remaining letters indicate its function. An H prefix indicates that the function is active in the high state; an L prefix indicates that it is active in the low state. For devices that are edge sensitive the prefix "P" indicates that the function is active on the positive going edge; the prefix "N" indicates that the device is active on the negative going edge.

## TO/FROM MEMORY CONTROLLER

LEDO-15	LOW EMULATOR DATA 0-15. Bidirectional bus between the data transceivers (U3K-U3N) and the emulation memory control board. This bus carries all data information for emulation processor and mainframe computer data transactions with emulation memory.
LMA0-18	LOW MEMORY ADDRESS 0-18. Input to the address decoders and the address buffers from the emulation memory controller. These are active low lines. LMA14-LMA18 are input to the address decoders, which select the correct row of RAM for a transaction; and LMA0-13 are input to the address buffers, which drive the address lines of the RAM's to select the desired memory location within the row.
LWRL	LOW WRITE LOWER. Input to U2K from the Memory Controller. When low, indicates that the controller wishes to write data into the lower byte of the selected and addressed row of RAM (D0-7), either for an emulation or mainframe computer write cycle.
LWRU	LOW WRITE UPPER. Input to U2K from the emulation memory controller. When low, indicates that the controller wishes to write data into the upper byte of RAM (D8-15), either for an emulation or mainframe computer write cycle.
RD/LWRT	READ/WRITE. Input from the emulation memory control board to the data buffer control gating and the data transceiver control logic. A low on this line enables one-half of transceivers U3K-U3N so that data from the emulation memory controller may be driven to the RAM data inputs during a write cycle. When RD/LWRT is high it allows the transceivers to be oriented for a data read cycle whenever a row of RAM is selected on the board.

## TO/FROM CPU MAINFRAME

- LID           LOW ID. Enables Memory Board to output its ID code onto the Low Data Bus to the CPU.
- LSEL          LOW SLOT SELECT. When low enables the slot select buffer on the mainframe.
- LD0-8        LOW DATA 0-8. When low these lines identify the Memory Board to the Mainframe CPU.  
                   01F8        64161A/162A/163A  
                   01F9        64162A  
                   01FA        64163A
- LSTB         LOW STROBE. Active low, during write operation, indicates data bus information is valid; during read operation indicates CPU is not driving the data bus and addressed device can drive data bus.

## INTRABOARD MNEMONICS

- A0-13"       ADDRESS 0-13". Output from address buffers U2C-U2F, and input to the RAM array. These lines are used to select the desired memory location in the rows 3 and 4 of RAM for the data transfer (read or write cycle).
- A0-13'        ADDRESS 0-13'. Output from address buffers U2C-U2F, and input to the RAM array. These lines are used to select the desired memory location in the rows 1 and 2 of RAM for the data transfer (read or write cycle).
- DIN0-15       DATA IN 0-15. Input to the RAM array from data transceivers U3k-3N. This bus is used to provide the desired information for storage in the selected RAM location during a data write cycle.
- DOUT0-15      DATA OUT 0-15. Output to the memory bus from the RAM array through data transceivers Ux-Ux. Valid data will be presented on this bus by the selected row of the RAM array whenever a location is addressed, the CS/line is asserted, and the WE/ line of the RAM's is left high.
- HRDEN         HIGH READ ENABLE. Output generated by U3GB whenever any one of the four rows of memory are selected by the Row Select Decoders. When HRDEN and RD/LWRT are both high U3JA generates a low signal which enables the data transceivers U3K-U3N.

LINVMA18	LOW INVERTED MEMORY ADDRESS 18. When this signal is low (LMA18 is high) and LMA17 is high U2J is enabled; when this signal is low and LMA 17 is low U2I is enabled.
LRD	LOW READ. This signal, generated when HRDEN and RD/WRT are both high enables the data transceivers to be read.
ROWSEL1-4	ROW SELECT 1-4. Output from the pullup/damping network (CR1-7 and RP1,R6-9), which is driven by the address decoders through the address range jumpers. A low on one of these lines selects the corresponding row of RAM for a data transaction by asserting the RAM's chip select line.

Table 8-2. Logic Symbols

**GENERAL**

All signals flow from left to right, relative to the symbol's orientation with inputs on the left side of the symbol, and outputs on the right side of the symbol (the symbol may be reversed if the dependency notation is a single term.)

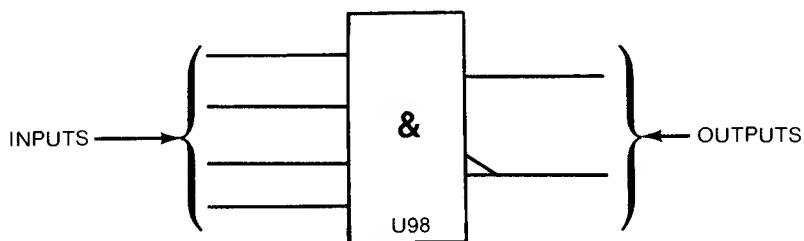
All dependency notation is read from left to right (relative to the symbol's orientation).

An external state is the state of an input or output outside the logic symbol.

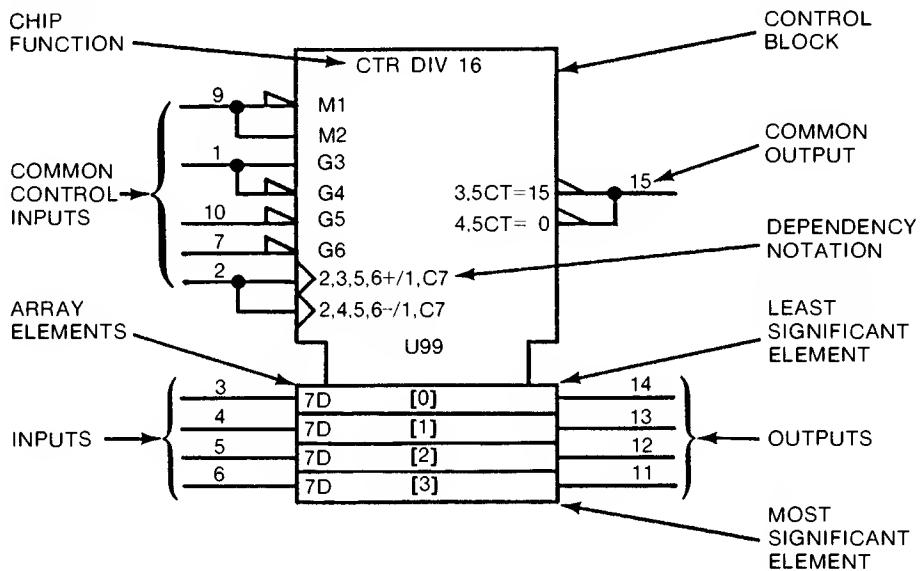
An internal state is the state of an input or output inside the logic symbol. All internal states are True = High.

**SYMBOL CONSTRUCTION**

Some symbols consist of an outline or combination of outlines together with one or more qualifying symbols, and the representation of input and output lines.



Some have a common Control Block with an array of elements:



**CONTROL BLOCK** - All inputs and dependency notation affect the array elements directly. Common outputs are located in the control block. (Control blocks may be above or below the array elements.)

**ARRAY ELEMENTS** - All array elements are controlled by the control block as a function of the dependency notation. Any array element is independent of all other array elements. Unless indicated, the least significant element is always closest to the control block. The array elements are arranged by binary weight. The weights are indicated by powers of 2 (shown in [ ]).

Table 8-2. Logic Symbols (con't)

**INPUTS** - Inputs are located on the left side of the symbol and are affected by their dependency notation.

Common control inputs are located in the control block and control the inputs/outputs to the array elements according to the dependency notation.

Inputs to the array elements are located with the corresponding array element with the least significant element closest to the control block.

**OUTPUTS** - Outputs are located on the right side of the symbol and are effected by their dependency notation.

Common control outputs are located in the control block.

Outputs of array elements are located in the corresponding array element with the least significant bit closest to the control block.

**CHIP FUNCTION** - The labels for chip functions are defined, i.e., CTR - counter, MUX - multiplexer.

## DEPENDENCY NOTATION

Dependency notation is always read from left to right relative to the symbol's orientation.

Dependency notation indicates the relationship between inputs, outputs, or inputs and outputs. Signals having a common relationship will have a common number, i.e., C7 and 7D...C7 controls D. Dependency notation 2,3,5,6+/1,C7 is read as when 2 and 3 and 5 and 6 are true, the input will cause the counter to increment by one count....or (/) the input (C7) will control the loading of the input value (7D) into the D flip-flops.

The following types of dependencies are defined:

- a. AND (G), OR (V), and Negate (N) denote Boolean relationship between inputs and outputs in any combination.
- b. Interconnection (Z) indicates connections inside the symbol.
- c. Control (C) identifies a timing input or a clock input of a sequential element and indicates which inputs are controlled by it.
- d. Set (S) and Reset (R) specify the internal logic states (outputs) of an RS bistable element when the R or S input stands at its internal 1 state.
- e. Enable (EN) identifies an enable input and indicates which inputs and outputs are controlled by it (which outputs can be in their high impedance state).
- f. Mode (M) identifies an input that selects the mode of operation of an element and indicates the inputs and outputs depending on that mode.
- g. Address (A) identifies the address inputs.
- h. Transmission (X) identifies bi-directional inputs and outputs that are connected together when the transmission input is true.

### DEPENDENCY NOTATION SYMBOLS

A	Address (selects inputs/outputs) (indicates binary range)	N	Negate (compliments state)
C	Control (permits action)	R	Reset Input
EN	Enable (permits action)	S	Set Input
G	AND (permits action)	V	OR (permits action)
M	Mode (selects action)	Z	Interconnection
		X	Transmission

Table 8-2. Logic Symbols (con't)

OTHER SYMBOLS			
	Analog Signal		Inversion
	AND		Negation
	Bit Grouping		Nonlogic Input/Output
	Buffer		Open Circuit (external resistor)
	Compare		Open Circuit (external resistor)
	Dynamic		OR
	Exclusive OR		Passive Pull Down (internal resistor)
	Hysteresis		Passive Pull Up (internal resistor)
	Interrogation		Postponed
	Internal Connection		Shift Left (or up)
			Shift Right (or down)
			Solidus (allows an input or output to have more than one function)
			Tri-State
		,	Causes notation and symbols to effect inputs/outputs in an AND relationship, and to occur in the order read from left to right.
		( )	Used for factoring terms using algebraic techniques.
		[ ]	Information not defined.
		Φ	Logic symbol not defined due to complexity.
LABELS			
BG	Borrow Generate	CO	Carry Output
BI	Borrow Input	CP	Carry Propagate
BO	Borrow Output	CT	Content
BP	Borrow Propagate	D	Data Input
CG	Carry Generate	E	Extension (input or output)
CI	Carry Input	F	Function
		J	J Input
		K	K Input
		P	Operand
		T	Transition
		+	Count Up
		-	Count Down
MATH FUNCTIONS			
$\Sigma$	Adder	>	Greater Than
ALU	Arithmetic Logic Unit	<	Less Than
COMP	Comparator	CPG	Look Ahead Carry Generator
DIV	Divide By	Π	Multiplier
=	Equal To	P-Q	Subtractor
CHIP FUNCTIONS			
BCD	Binary Coded Decimal	DIR	Directional
BIN	Binary	DMUX	Demultiplexer
BUF	Buffer	FF	Flip-Flop
CTR	Counter	MUX	Multiplexer
DEC	Decimal	OCT	Octal
		RAM	Random Access Memory
		RCVR	Line Receiver
		ROM	Read Only Memory
		SEG	Segment
		SRG	Shift Register
DELAY and MULTIVIBRATORS			
	Astable		
	Delay		
	Nonretriggerable Monostable		
	Nonvolatile		
	Retriggerable Monostable		

Table 8-3. Schematic Diagram Notes

	ETCHED CIRCUIT BOARD	(925)	WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE
	FRONT PANEL MARKING		{ (925) IS WHT-RED-GRN   0 - BLACK    5 - GREEN 1 - BROWN   6 - BLUE 2 - RED      7 - VIOLET 3 - ORANGE   8 - GRAY 4 - YELLOW   9 - WHITE
	REAR-PANEL MARKING		
	MANUAL CONTROL	*	OPTIMUM VALUE SELECTED AT FACTORY, TYPICAL VALUE SHOWN; PART MAY HAVE BEEN OMITTED.
	SCREWDRIVER ADJUSTMENT		
	TP1 ELECTRICAL TEST POINT TP (WITH NUMBER)		UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS CAPACITANCE IN PICOFARADS INDUCTANCE IN MICROHENRIES
	NUMBERED WAVEFORM NUMBER CORRESPONDS TO ELECTRICAL TEST POINT NO.	$\mu$ P = P/O = NC =	MICROPROCESSOR PART OF NO CONNECTION
	LETTERED TEST POINT NO MEASUREMENT AID PROVIDED	CW =	CLOCKWISE END OF VARIABLE RESISTOR
	COMMON CONNECTIONS. ALL LIKE-DESIGNATED POINTS ARE CONNECTED.		
	① 3 NUMBER ON WHITE BACKGROUND = OFF-PAGE CONNECTION. LARGE NUMBER ADJACENT = SERVICE SHEET NUMBER FOR OFF-PAGE CONNECTION.		
	CIRCLED LETTER = OFF-PAGE CONNECTION BETWEEN PAGES OF SAME SERVICE SHEET.		
—	INDICATES SINGLE SIGNAL LINE		
	NUMBER OF LINES ON A BUS		

STD-20-09-81

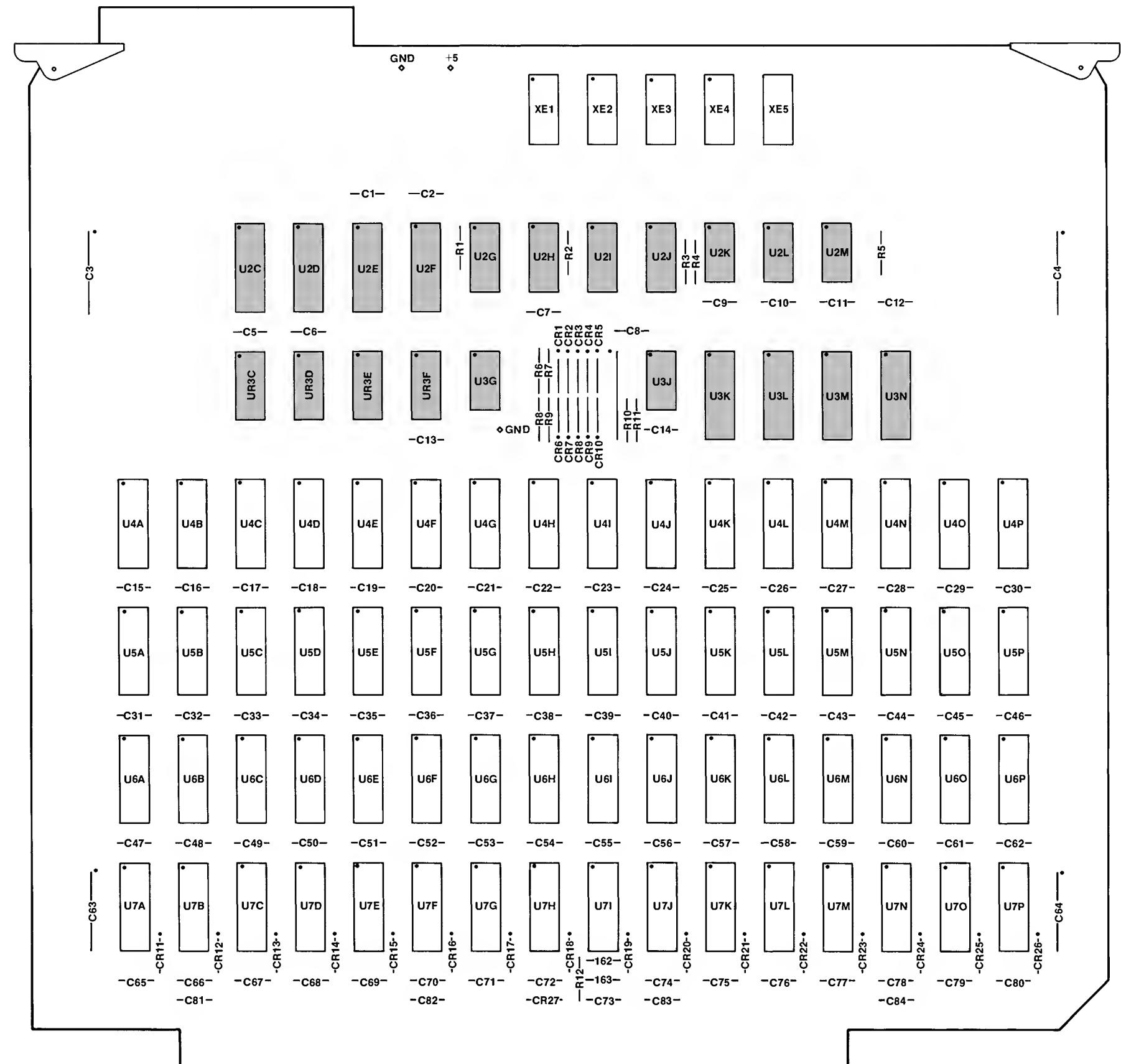
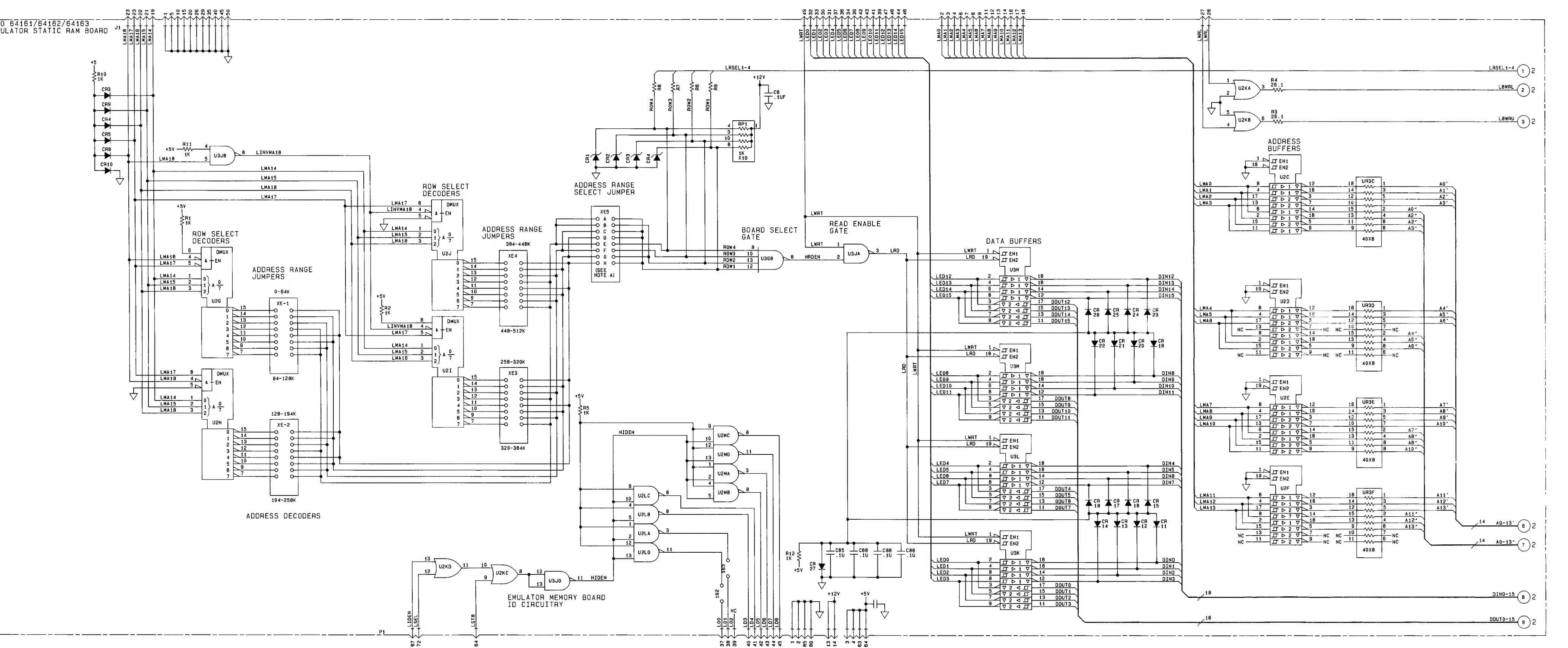
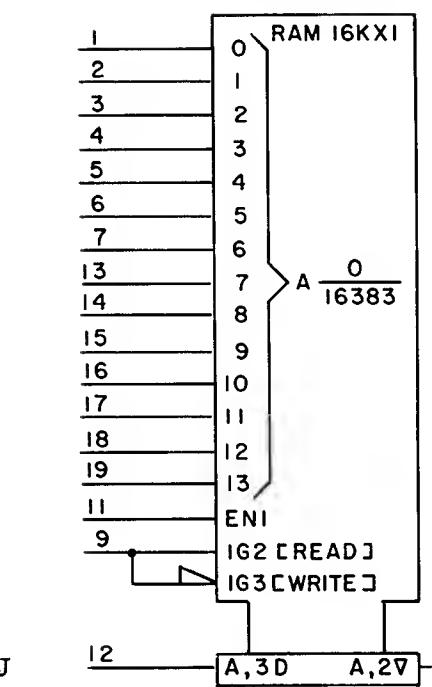


Figure 8-3. Model 64161A/162A/163A Component Locator

Figure 8-4. Service Sheet 1  
8-13

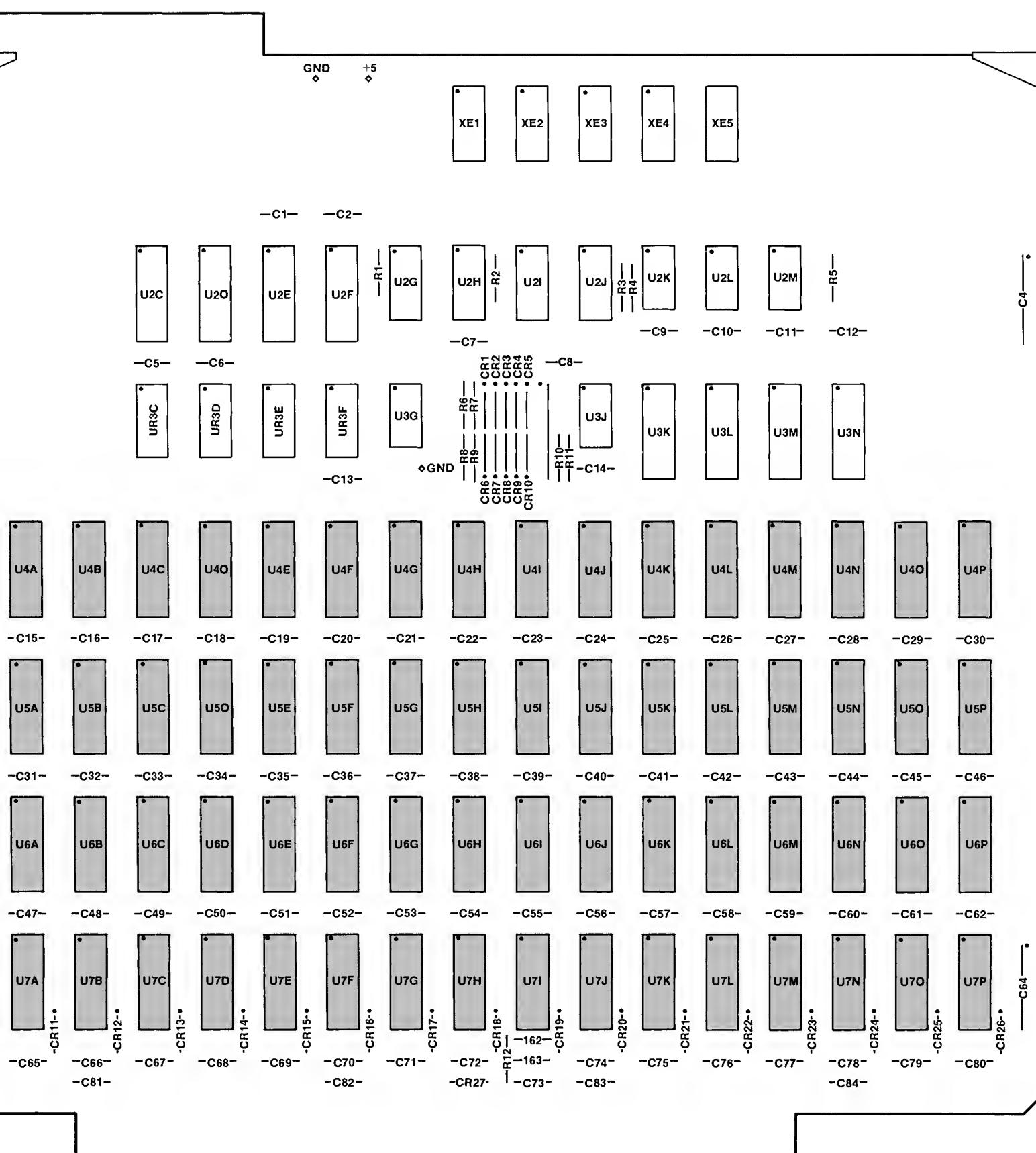
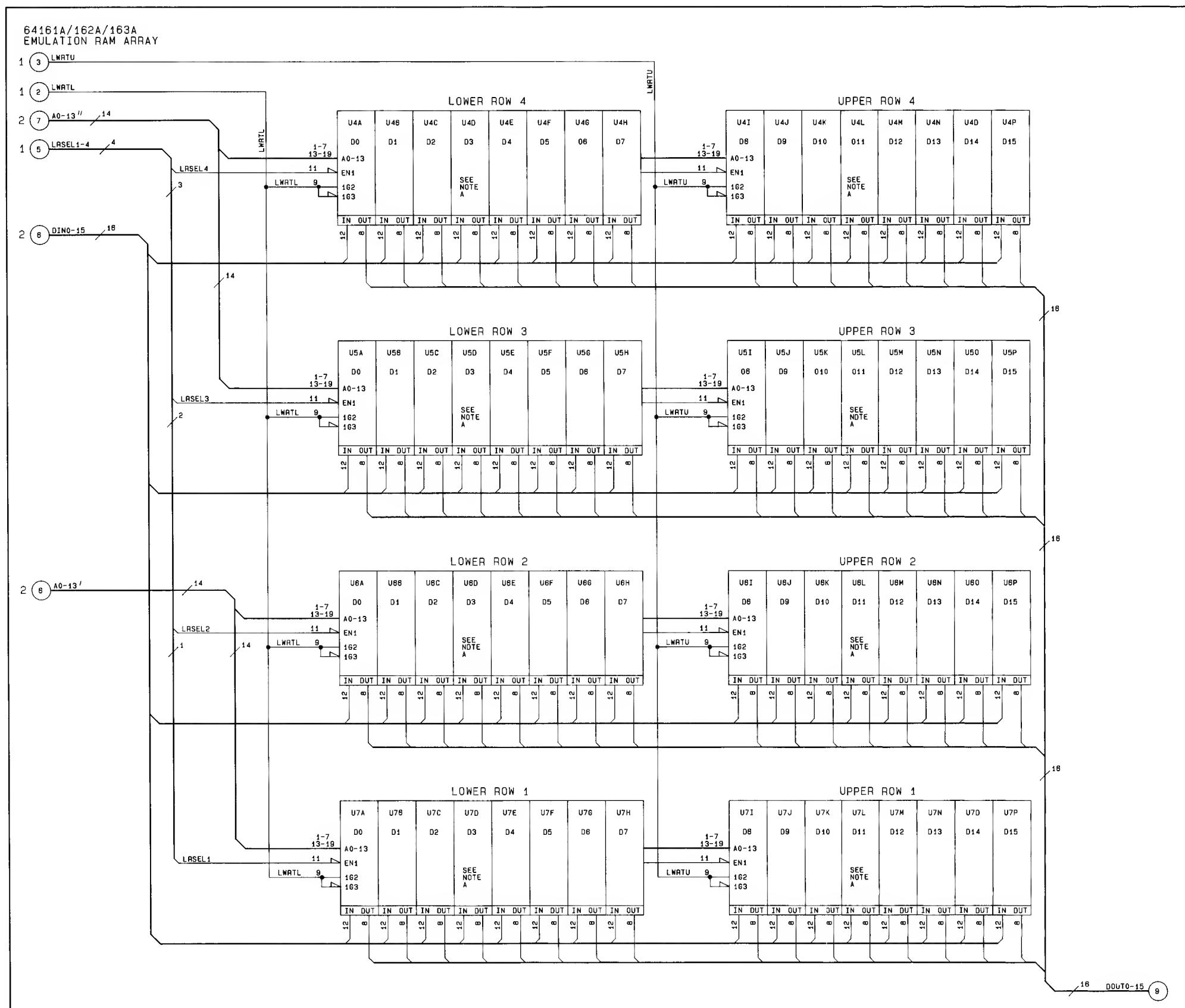


Figure 8-5. Model 64161A/162A/163A Component Locator  
8-14



IC'S ON THIS SCHEMATIC

U4A-U4P	HM6167	1818-1969
U5A-U5P	HM6167	1818-1969
U6A-U6P	HM6167	1818-1969
U7A-U7P	HM6167	1818-1969

PARTS ON THIS SCHEMATIC

CR15-30, CR31-46, CR47-62, CR65-84

+5V 20 10 U4A-U4P, U5A-U5P, U6A-U6P, U7A-U7P

Figure 8-6. Service Sheet 2



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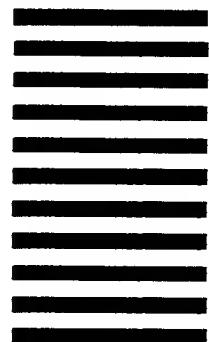
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## READER COMMENT SHEET

Service Manual, Model 64161A/162A/163A

Emulation Memory

64161-90901, January 1984

Part Number: \_\_\_\_\_

Your comments are important to us. Please answer this questionnaire and return it to us. Circle the number that best describes your answer in questions 1 through 7. Thank you.

1. The information in this book is complete:

Doesn't cover enough (what more do you need?)	1    2    3    4    5	Covers everything
--	-----------------------	-------------------

2. The information in this book is accurate:

Too many errors	1    2    3    4    5	Exactly right
-----------------	-----------------------	---------------

3. The information in this book is easy to find:

I can't find things I need	1    2    3    4    5	I can find info quickly
----------------------------	-----------------------	-------------------------

4. The Index and Table of Contents are useful:

Helpful	1    2    3    4    5	Missing or inadequate
---------	-----------------------	-----------------------

5. What about the "how-to" procedures and examples:

No help	1    2    3    4    5	Very helpful
---------	-----------------------	--------------

Too many now	1    2    3    4    5	I'd like more
--------------	-----------------------	---------------

6. What about the writing style:

Confusing	1    2    3    4    5	Clear
-----------	-----------------------	-------

7. What about organization of the book:

Poor order	1    2    3    4    5	Good order
------------	-----------------------	------------

8. What about the size of the book:

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Comments: \_\_\_\_\_  
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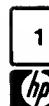
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**0-4000 DUSSELDORF**  
 Tel: (0211) 5971-1  
 Telex: 085/86 533 hpdd d  
 A,CH,CS,E,MS,P  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Schleefstr. 28a  
**0-4600 DORTMUND-Aplerbeck**  
 Tel: (0231) 45001  
**Hewlett-Packard GmbH**  
 Vertriebszentrale Frankfurt  
 Berner Strasse 117  
 Postfach 560 140  
**0-6000 FRANKFURT 56**  
 Tel: (0611) 50-04-1  
 Telex: 04 13249 hpffm d  
 A,CH,CM,CS,E,MP,P  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Aussenstelle Bad Homburg  
 Louisenstrasse 115  
**0-6380 BAD HOMBURG**  
 Tel: (06172) 109-0  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Kapstadtring 5  
**0-2000 HAMBURG 60**  
 Tel: (040) 63804-1  
 Telex: 021 63 032 hphh d  
 A,CH,CS,E,MS,P  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Heidering 37-39  
**0-3000 HANNOVER 61**  
 Tel: (0511) 5706-0  
 Telex: 092 3259  
 A,CH,CM,E,MS,P  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Rosslauer Weg 2-4  
**0-6800 MANNHEIM**  
 Tel: (0621) 70050  
 Telex: 0462105  
 A,C,E  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Messerschmittstrasse 7  
**0-7910 NEU ULM**  
 Tel: 0731-70241  
 Telex: 07 12816 HP ULM-0  
 A,C,E  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Ehhericherstr. 13  
**0-8500 NÜRNBERG 10**  
 Tel: (0911) 5205-0  
 Telex: 0623 860  
 CH,CM,E,MS,P  
**Hewlett-Packard GmbH**  
 Geschäftsstelle  
 Eschenstrasse 5  
**0-8028 TAUFKIRCHEN**  
 Tel: (089) 6117-1  
 Telex: 0524985  
 A,CH,CM,E,MS,P

**GREAT BRITAIN**  
**See United Kingdom**

**GREECE**  
**Kostas Karaynnis S.A.**  
**8 Omirou Street**  
**ATHENS 133**  
**Tel: 32 30 303, 32 37 371**  
**Telex: 215962 RKAR GR**  
 A,CH,CM,CS,E,MP,P  
**PLAISIO S.A.**  
**G. Gerardos**  
**24 Stournara Street**  
**ATHENS**  
**Tel: 36-11-160**  
**Telex: 221871**  
 P

## GUATEMALA

**IPESA**  
*Avenida Reforma 3-48, Zona 9*  
**GUATEMALA CITY**  
*Tel: 316627, 314786*  
*Telex: 4192 TELTRO GU*  
 A,CH,CM,CS,E,MP

## HONG KONG

**Hewlett-Packard Hong Kong, Ltd.**  
 G.P.O. Box 795  
 5th Floor, Sun Hung Kai Centre  
 30 Harbour Road  
**HONG KONG**  
 Tel: 5-8323211  
 Telex: 66678 HEWPA HX  
 Cable: HEWPACK HONG KONG  
 E,CH,OS,P  
**CET Ltd.**  
*1402 Tung Wah Mansion*  
*199-203 Hennessy Rd.*  
*Wanchia, HONG KONG*  
 Tel: 5-729376  
 Telex: 85148 CET HX  
 CM  
*Schmidt & Co. (Hong Kong) Ltd.*  
*Wing On Centre, 28th Floor*  
*Connaught Road, C.*  
**HONG KONG**  
 Tel: 5-455644  
 Telex: 74766 SCHMX HX  
 A,M

## ICELAND

**Elding Trading Company Inc.**  
*Hafnarfjölli-Tryggvagötu*  
*P.O. Box 895*  
**IS-REYKJAVIK**  
*Tel: 1-58-20, 1-63-03*  
 M

## INDIA

Computer products are sold through  
 Blue Star Ltd. All computer repairs and  
 maintenance service is done through  
 Computer Maintenance Corp.

**Blue Star Ltd.**  
*Sabri Complex II Floor*  
*24 Residency Rd.*  
**BANGALORE 560 025**  
 Tel: 55660  
 Telex: 0845-430  
 Cable: BLUESTAR  
 A,CH\*,CM,CS\*,E

**Computer Maintenance Corporation**  
 Ltd.  
*115, Sarojini Devi Road*  
**SECUNDERABAD 500 003**  
 Tel: 310-184, 345-774  
 Telex: 031-2960  
 CH\*\*

**Blue Star Ltd.**  
**Band Box House**  
**Prabhadevi**  
**BOMBAY 400 025**  
**Tel: 422-3101**  
**Telex: 011-3751**  
**Cable: BLUESTAR**  
 A,M  
**Blue Star Ltd.**  
**Sahas**  
*414/2 Vir Savarkar Marg*  
**Prabhadevi**  
**BOMBAY 400 025**  
**Tel: 422-6155**  
**Telex: 011-4093**  
**Cable: FROSTBLUE**  
 A,CH\*,CM,CS\*,E,M  
**Blue Star Ltd.**  
*Kalyan, 19 Vishwas Colony*  
*Alkapuri, BORODA, 390 005*  
**Tel: 65235**  
**Cable: BLUE STAR**  
 A

**Blue Star Ltd.**  
*7 Hare Street*  
**CALCUTTA 700 001**  
**Tel: 12-01-31**  
**Telex: 021-7655**  
**Cable: BLUESTAR**  
 A,M

**Blue Star Ltd.**  
*133 Kodambakkam High Road*  
**MADRAS 600 034**  
**Tel: 82057**  
**Telex: 041-379**  
**Cable: BLUESTAR**  
 A,M

**Blue Star Ltd.**  
*Bhandari House, 7th/8th Floors*  
*91 Nehru Place*  
**NEW DELHI 110 024**  
**Tel: 682547**  
**Telex: 031-2463**  
**Cable: BLUESTAR**  
 A,CH\*,CM,CS\*,E,M

**Blue Star Ltd.**  
*15/16-C Wellesley Rd.*  
**PUNE 411 011**  
**Tel: 22775**  
**Cable: BLUE STAR**  
 A

**Blue Star Ltd.**  
*2-2-47/1108 Bolarum Rd.*  
**SECUNDERABAD 500 003**  
**Tel: 72057**  
**Telex: 0155-459**  
**Cable: BLUEFROST**  
 A,E

**Blue Star Ltd.**  
*T.C. 7/603 Poornima*  
*Maruthankuzhi*  
**TRIVANDRUM 695 013**  
**Tel: 65799**  
**Telex: 0884-259**  
**Cable: BLUESTAR**  
 E

**Computer Maintenance Corporation**  
 Ltd.  
*115, Sarojini Devi Road*  
**SECUNDERABAD 500 003**  
 Tel: 310-184, 345-774  
 Telex: 031-2960  
 CH\*\*



# SALES & SUPPORT OFFICES

Arranged alphabetically by country

## INDONESIA

*BERCA Indonesia P.T.*  
P.O.Box 496/Jkt.

Jl. Abdul Muis 62  
**JAKARTA**

Tel: 21-373009

Telex: 46748 BERSAL IA

Cable: BERSAL JAKARTA  
P

*BERCA Indonesia P.T.*

P.O.Box 2497/Jkt

Antara Bldg., 17th Floor

Jl. Medan Merdeka Selatan 17

**JAKARTA-PUSAT**

Tel: 21-344-181

Telex: BERSAL IA

A,C,S,E,M

*BERCA Indonesia P.T.*

P.O. Box 174/SBY.

Jl. Kutei No. 11

**SURABAYA**

Tel: 68172

Telex: 31146 BERSAL SB

Cable: BERSAL-SURABAYA

A\*,E,M,P

## IRAQ

Hewlett-Packard Trading S.A.

Service Operation

Al Mansoor City 9B/3/7

**BAGHDAD**

Tel: 551-49-73

Telex: 212-455 HEPAIRAQ IK

CH,CS

## IRELAND

Hewlett-Packard Ireland Ltd.

82/83 Lower Leeson Street

**DUBLIN 2**

Tel: 0001 608800

Telex: 30439

A,CH,CM,CS,E,M,P

*Cardiac Services Ltd.*

Kilmore Road

Arlane

**DUBLIN 5**

Tel: (01) 351820

Telex: 30439

M

## ISRAEL

*Eldan Electronic Instrument Ltd.*

P.O.Box 1270

**JERUSALEM 91000**

16, Ohalav St.

**JERUSALEM 94467**

Tel: 533 221, 553 242

Telex: 25231 AB/PAKRD IL

A

*Electronics Engineering Division*

*Motorola Israel Ltd.*

16 Kremenetski Street

P.O. Box 25016

**TEL-AVIV 67899**

Tel: 3 88 388

Telex: 33569 Motil IL

Cable: BASTEL Tel-Aviv

CH,CM,CS,E,M,P

## ITALY

Hewlett-Packard Italiana S.p.A

Traversa 99C

Via Giulio Petroni, 19

**I-70124 BARI**

Tel: (080) 41-07-44

M

Hewlett-Packard Italiana S.p.A.

Via Martin Luther King, 38/III

I-40132 BOLOGNA

Tel: (051) 402394

Telex: 511630

CH,E,MS

Hewlett-Packard Italiana S.p.A.

Via Principe Nicola 43G/C

I-95126 CATANIA

Tel: (095) 37-10-87

Telex: 970291

C,P

Hewlett-Packard Italiana S.p.A.

Via G. Oi Vittorio 9

I-20063 CERNUSCO SUL NAVIGLIO

(Milano)

Tel: (02) 923691

Telex: 334632

A,CH,CM,CS,E,MP,P

Hewlett-Packard Italiana S.p.A.

Via C. Colombo 49

I-20090 TREZZANO SUL NAVIGLIO

(Milano)

Tel: (02) 4459041

Telex: 322116

C,M

Hewlett-Packard Italiana S.p.A.

Via Nuova San Rocco a

Capodimonte, 62/A

I-80131 NAPOLI

Tel: (081) 7413544

Telex: 710698

A,CH,E

Hewlett-Packard Italiana S.p.A.

Viale G. Modugno 33

I-16156 GENOVA PEGLI

Tel: (010) 68-37-07

Telex: 215238

E,C

Hewlett-Packard Italiana S.p.A.

Via Pelizzo 15

I-35128 PADOVA

Tel: (049) 664888

Telex: 430315

A,CH,E,MS

Hewlett-Packard Italiana S.p.A.

Viale C. Pavese 340

I-00144 ROMA EUR

Tel: (06) 54831

Telex: 6 105 14

A,CH,CM,CS,E,MS,P\*

Hewlett-Packard Italiana S.p.A.

Via di Casellina 57/C

I-50018 SCANDICCI-FIRENZE

Tel: (055) 753863

Hewlett-Packard Italiana S.p.A.

Corso Svizzera, 185

I-10144 TORINO

Tel: (011) 74 4044

Telex: 221079

CH,E

## JAPAN

*Yokogawa-Hewlett-Packard Ltd.*

152-1, Onna

ATSUGI, Kanagawa, 243

Tel: (0462) 28-0451

CM,C\*,E

*Yokogawa-Hewlett-Packard Ltd.*

Meiji-Seimei Bldg. 6F

3-1 Hon Chiba-Cho

CHIBA, 280

Tel: 472 25 7701

E,CH,CS

Yokogawa-Hewlett-Packard Ltd.

Yasuda-Seimei Hiroshima Bldg.

6-11, Hon-dori, Naka-ku

**HIROSHIMA, 730**

Tel: 82-241-0611

Yokogawa-Hewlett-Packard Ltd.

Towa Building

2-3, Kaigan-dori, 2 Chome Chuo-ku

**KOBE, 650**

Tel: (078) 392-4791

C,E

Yokogawa-Hewlett-Packard Ltd.

Kumagaya Asahi 82 Bldg

3-4 Tsukuba

**KUMAGAYA, Saitama 360**

Tel: (0485) 24-6563

CH,CM,E

Yokogawa-Hewlett-Packard Ltd.

Asahi Shinbun Oaiichi Seimei Bldg.

4-7, Hanabata-cho

**KUMAMOTO, 860**

Tel: (0963) 54-7311

CH,E

Yokogawa-Hewlett-Packard Ltd.

Mito Mitsui Bldg

4-73, Sanno-maru, 1 Chome

**MITO, Ibaraki 310**

Tel: (0292) 25-7470

CH,CM,E

Yokogawa-Hewlett-Packard Ltd.

Sumitomo Seimei 14-9 Bldg.

Meieki-Minami, 2 Chome

Nakamura-ku

**NAGOYA, 450**

Tel: (052) 571-5171

CH,CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.

Chuo Bldg.,

4-20 Nishinakajima, 5 Chome

Yodogawa-ku

**OSAKA, 532**

Tel: (06) 304-6021

Telex: YHPOSA 523-3624

A,CH,CM,CS,E,MP,P\*

Yokogawa-Hewlett-Packard Ltd.

27-15, Yabe, 1 Chome

**SAGAMIHARA Kanagawa, 229**

Tel: 0427 59-1311

Yokogawa-Hewlett-Packard Ltd.

Oaiichi Seimei Bldg.

7-1, Nishi Shinjuku, 2 Chome

Shinjuku-ku,TOKYO 160

Tel: 03-348-4611

CH,E

Yokogawa-Hewlett-Packard Ltd.

29-21 Taikaido-Higashi, 3 Chome

Suginami-ku TOKYO 168

Tel: (03) 331-611

Telex: 232-2024 YHPTOK

A,CH,CM,CS,E,MP,P\*

Yokogawa-Hewlett-Packard Ltd.

Oaiichi Asano Building

2-8, Odori, 5 Chome

**UTSUNOMIYA, Tochigi 320**

Tel: (0286) 25-7155

CH,CS,E

Yokogawa-Hewlett-Packard Ltd.

Yasuda Seimei Nishiguchi Bldg.

30-4 Tsuruya-cho, 3 Chome

**YOKOHAMA 221**

Tel: (045) 312-1252

CH,CM,E

## JORDAN

*Mouasher Cousins Company*

P.O. Box 1387

**AMMAN**

Tel: 24907, 39907

Telex: 21456 SABCO JO

CH,E,M,P

## KENYA

*ADCOM Ltd., Inc., Kenya*

P.O.Box 30070

**NAIROBI**

Tel: 331955

Telex: 22639

E,M

## KOREA

*Samsung Electronics HP Division*

12 Fl. Kinam Bldg.

San 75-31, Yeoksam-Dong

Kangnam-Ku

Yeongdong P.O. Box 72

**SEOUL**

Tel: 555-7555, 555-5447

Telex: K27364 SAMSAN

A,CH,CM,CS,E,M,P

## KUWAIT

*Al-Khalidiya Trading & Contracting*

P.O. Box 830 Safat

**KUWAIT**

Tel: 42-4910, 41-1726

Telex: 22481 Areeg kt

CH,E,M

*Photo & Cine Equipment*

P.O. Box 270 Safat

**KUWAIT**

Tel: 42-2846, 42-3801

Telex: 22247 Matin kt

P

## LEBANON

*G.M. Dolmadjian*

Achrafieh

P.O. Box 165. 167

**BEIRUT**

Tel: 290293

MP\*\*

*Computer Information Systems*

# SALES & SUPPORT OFFICES

Arranged alphabetically by country



## MAYLAYSIA (Cont'd)

**Protel Engineering**  
P.O.Box 1917  
Lot 6624, Section 64  
23/4 Pending Road  
**Kuching, SARAWAK**  
Tel: 36299  
Telex: MA 70904 PROMAL  
Cable: PROTELENG  
A,E,M

## MALTA

**Philip Toledo Ltd.**  
Notabile Rd.  
**MRIEHEL**  
Tel: 447 47, 455 66  
Telex: Media MW 649  
E,P

## MEXICO

**Hewlett-Packard Mexicana, S.A. de C.V.**  
Av. Periferico Sur No. 6501  
Tepepan, Xochimilco  
16020 MEXICO D.F.  
Tel: 6-76-46-00  
Telex: 17-74-507 HEWPACK MEX  
A,CH,CS,E,MS,P  
**Hewlett-Packard Mexicana, S.A. de C.V.**  
Ave. Colonia del Valle 409  
Col. del Valle  
Municipio de Garza Garcia  
**MONTERREY**, Nuevo Leon  
Tel: 78 42 41  
Telex: 038 410  
CH  
**ECISA**  
José Vasconcelos No. 218  
Col. Condesa Deleg. Cuauhtémoc  
**MEXICO D.F. 06140**  
Tel: 553-1206  
Telex: 17-72755 ECE ME  
M

## MOROCCO

**Dolbeau**  
81 rue Karatchi  
**CASABLANCA**  
Tel: 3041-82, 3068-38  
Telex: 23051, 22822  
E  
**Gerep**  
2 rue d'Agadir  
Boite Postale 156  
**CASABLANCA**  
Tel: 272093, 272095  
Telex: 23 739  
P

## NETHERLANDS

**Hewlett-Packard Nederland B.V.**  
Van Heuven Goedhartlaan 121  
NL 1181KK AMSTELVEEN  
P.O. Box 667  
NL1180 AR AMSTELVEEN  
Tel: (020) 47-20-21  
Telex: 13 216 HEPA NL  
A,CH,CM,CS,E,MP,P  
**Hewlett-Packard Nederland B.V.**  
Bongerd 2  
NL 2906VK CAPELLE A/D IJssel  
P.O. Box 41  
NL 2900AA CAPELLE A/D IJssel  
Tel: (10) 51-64-44  
Telex: 21261 HEPAC NL  
A,CH,CS,E

**Hewlett-Packard Nederland B.V.**  
Pastoor Petersstraat 134-136  
NL 5612 LV EINDHOVEN  
P.O. Box 2342  
NL 5600 CH EINDHOVEN  
Tel: (040) 326911  
Telex: 51484 hepac nl  
A,CH\*,E,M

## NEW ZEALAND

**Hewlett-Packard (N.Z.) Ltd.**  
5 Owens Road  
P.O. Box 26-189  
Epsom, AUCKLAND  
Tel: 687-159  
Cable: HEWPACK Auckland  
CH,CM,E,P\*

**Hewlett-Packard (N.Z.) Ltd.**  
4-12 Crickshank Street  
Kilbirnie, WELLINGTON 3  
P.O. Box 9443  
Courtenay Place, WELLINGTON 3

Tel: 877-199  
Cable: HEWPACK Wellington  
CH,CM,E,P

**Northrop Instruments & Systems Ltd.**  
369 Khyber Pass Road

P.O. Box 8602

**AUCKLAND**  
Tel: 794-091  
Telex: 60605  
A,M

**Northrop Instruments & Systems Ltd.**  
110 Mandeville St.

P.O. Box 8388  
**CHRISTCHURCH**  
Tel: 486-928  
Telex: 4203  
A,M

**Northrop Instruments & Systems Ltd.**  
Sturdee House  
85-87 Ghuznee Street

P.O. Box 2406  
**WELLINGTON**  
Tel: 850-091  
Telex: NZ 3380  
A,M

## NORTHERN IRELAND

### See United Kingdom

## NORWAY

**Hewlett-Packard Norge A/S**  
Folke Bernadottes vei 50  
P.O. Box 3558  
N-5033 FYLLINGSDALEN (Bergen)  
Tel: 0047/5/16 55 40  
Telex: 16621 hpnas n  
CH,CS,E,MS

**Hewlett-Packard Norge A/S**

Österndalen 16-18  
P.O. Box 34  
N-1345 ÖSTERÅS  
Tel: 0047/2/17 11 80  
Telex: 16621 hpnas n  
A,CH,CM,CS,E,MP,P

## OMAN

**Khimji Ramdas**  
P.O. Box 19  
**MUSCAT**  
Tel: 722225, 745601  
Telex: 3289 BROKER MB MUSCAT  
P  
**Suhail & Saud Bahwan**  
P.O.Box 169  
**MUSCAT**  
Tel: 734 201-3  
Telex: 3274 BAHWAN MB

## PAKISTAN

**Mushko & Company Ltd.**  
1-B, Street 43  
Sector F-8/1  
**ISLAMABAD**  
Tel: 51071  
Cable: FEMUS Rawalpindi  
A,E,M

**Mushko & Company Ltd.**

**Oosman Chambers**

**Abdullah Haroon Road**

**KARACHI 0302**

Tel: 524131, 524132

Telex: 2894 MUSKO PK

Cable: COOPERATOR Karachi

A,E,M,P\*

## PANAMA

**Electrónico Balboa, S.A.**  
Calle Samuel Lewis, Ed. Alfa  
Apartado 4929  
**PANAMA 5**  
Tel: 63-66 13, 63-6748  
Telex: 3483 ELECTRON PG  
A,CM,E,P

## PERU

**Cía Electrónica Médica S.A.**  
Los Flamencos 145, San Isidro  
Casilla 1030  
**LIMA 1**  
Tel: 41-4325, 41-3703  
Telex: Pub. Booth 25306  
CM,E,M,P

## PHILIPPINES

**The Online Advanced Systems Corporation**  
Rico House, Amorsolo Cor. Herrera Street  
Legazpi Village, Makati  
P.O. Box 1510  
**Metro MANILA**  
Tel: 85-35-81, 85-34-91, 85-32-21  
Telex: 3274 ONLINE  
A,CH,CS,E,M

**Electronic Specialists and Proponents Inc.**

690-B Epifanio de los Santos Avenue  
Cubao, QUEZON CITY  
P.O. Box 2649 Manila  
Tel: 98-96-81, 98-96-82, 98-96-83  
Telex: 40018, 42000 ITT GLOBE  
MACKAY BOOTH  
P

## PORTUGAL

**Mundinter**  
**Intercambio Mundial de Comércio S.A.R.L.**  
P.O. Box 2761  
Av. António Augusto de Aguiar 138  
**P-LISBON**  
Tel: (19) 53-21-31, 53-21-37  
Telex: 16691 munter p  
M

**Soquímica**

Av. da Liberdade, 220-2  
1298 LISBOA Codex

Tel: 56 21 81/2/3

Telex: 13316 SABASA

P

**Telectra-Empresa Técnica de Equipamentos Eléctricos S.A.R.L.**

Rua Rodrigo da Fonseca 103

P.O. Box 2531

**P-LISBON 1**

Tel: (19) 68-60-72

Telex: 12598

CH,CS,E,P

## PUERTO RICO

**Hewlett-Packard Puerto Rico**  
Ave. Muñoz Rivera #101  
Esq. Calle Ochoa  
**HATO REY**, Puerto Rico 00918  
Tel: (809) 754-7800  
**Hewlett-Packard Puerto Rico**  
Calle 272 Edificio 203  
Urb. Country Club  
**RIO PIEDRAS**, Puerto Rico  
P.O. Box 4407  
**CAROLINA**, Puerto Rico 00628  
Tel: (809) 762-7255  
A,CH,CS

## QATAR

**Computearia**  
P.O. Box 2750  
**DOHA**  
Tel: 883555  
Telex: 4806 CHPARB  
P

**Eastern Technical Services**  
P.O.Box 4747

**DOHA**  
Tel: 329 993  
Telex: 4 156 EASTEC DH  
**Nasser Trading & Contracting**  
P.O.Box 1563  
DOHA  
Tel: 22170, 23539  
Telex: 4439 NASSER DH  
M

## SAUDI ARABIA

**Modern Electronic Establishment**  
**Hewlett-Packard Division**  
P.O. Box 22015  
**Thuobah**  
**AL-KHOBAR**  
Tel: 895-1760, 895-1764  
Telex: 671 106 HPMEK SJ  
Cable: ELECTRA AL-KHOBAR  
CH,CS,E,M

**Modern Electronic Establishment**  
**Hewlett-Packard Division**  
P.O. Box 1228

**Redec Plaza, 6th Floor**  
**JEDDAH**  
Tel: 644 38 48

Telex: 4027 12 FARNAS SJ  
Cable: ELECTRA JEDDAH  
CH,CS,E,M

**Modern Electronic Establishment**  
**Hewlett-Packard Division**  
P.O.Box 22015

**RIYADH**

Tel: 491-97 15, 491-63 87  
Telex: 202049 MEERYD SJ  
CH,CS,E,M

**Abdul Ghani El Ajou**

P.O. Box 78

**RIYADH**

Tel: 40 41 717  
Telex: 200 932 EL AJOU  
P

## SCOTLAND

### See United Kingdom

## SINGAPORE

**Hewlett-Packard Singapore (Sales) Pte. Ltd.**  
#08-00 Inchcape House  
450-2 Alexandra Road  
P.O. Box 58 Alexandra Rd. Post Office  
**SINGAPORE**, 9115  
Tel: 631788  
Telex: HPSGSO RS 34209  
Cable: HEWPACK, Singapore  
A,CH,CS,E,MS,P



# SALES & SUPPORT OFFICES

Arranged alphabetically by country

## SINGAPORE (Cont'd)

*Dynamar International Ltd.  
Unit 05-11 Block 6  
Kolam Ayer Industrial Estate  
SINGAPORE 1334  
Tel: 747-6188  
Telex: RS 26283  
CM*

## SOUTH AFRICA

*Hewlett-Packard So Africa (Pty.) Ltd.  
P.O. Box 120  
Howard Place CAPE PROVINCE 7450  
Pine Park Center, Forest Drive,  
Pinelands  
CAPE PROVINCE 7405  
Tel: 53-7954  
Telex: 57-20006  
A,CH,CM,E,MS,P  
Hewlett-Packard So Africa (Pty.) Ltd.  
P.O. Box 37099  
92 Overport Drive  
DURBAN 4067  
Tel: 28-4178, 28-4179, 28-4110  
Telex: 6-22954  
CH,CM*

*Hewlett-Packard So Africa (Pty.) Ltd.  
6 Linton Arcade  
511 Cape Road  
Linton Grange  
PORT ELIZABETH 6000  
Tel: 041-302148  
CH*

*Hewlett-Packard So Africa (Pty.) Ltd.  
P.O.Box 33345  
Glenstantia 0010 TRANSVAAL  
1st Floor East  
Constantia Park Ridge Shopping  
Centre  
Constantia Park  
PRETORIA  
Tel: 982043  
Telex: 32163  
CH,E*

*Hewlett-Packard So Africa (Pty.) Ltd.  
Private Bag Wendywood  
SANDTON 2144  
Tel: 802-5111, 802-5125  
Telex: 4-20877  
Cable: HEWPACK Johannesburg  
A,CH,CM,CS,E,MS,P*

## SPAIN

*Hewlett-Packard Española S.A.  
Calle Entenza, 321  
E-BARCELONA 29  
Tel: 322.24.51, 321.73.54  
Telex: 52603 hpbee  
A,CH,CS,E,MS,P*

*Hewlett-Packard Española S.A.  
Calle San Vicente S/No  
Edificio Albia II  
E-BILBAO 1  
Tel: 423.83.06  
A,CH,E,MS*

*Hewlett-Packard Española S.A.  
Ctra. de la Coruña, Km. 16, 400  
Las Rozas  
E-MADRID  
Tel: (1) 637.00.11  
CH,CS,M  
Hewlett-Packard Española S.A.  
Avda. S. Francisco Javier, S/no  
Planta 10. Edificio Sevilla 2,  
E-SEVILLA 5  
Tel: 64.44.54  
Telex: 72933  
A,CS,MS,P*

*Hewlett-Packard Española S.A.  
Calle Ramon Gordillo, 1 (Entlo.3)  
E-VALENCIA 10  
Tel: 361-1354  
CH,P*

## SWEDEN

*Hewlett-Packard Sverige AB  
Sunnanvagen 14K  
S-22226 LUND  
Tel: (046) 13-69-79  
Telex: (854) 17886 (via Spånga  
office)  
CH*

*Hewlett-Packard Sverige AB  
Östra Tulgatan 3  
S-21128 MÄLMO  
Tel: (040) 70270  
Telex: (854) 17886 (via Spånga  
office)*

*Hewlett-Packard Sverige AB  
Västra Vintergatan 9  
S-70344 ÖREBRO  
Tel: (19) 10-48-80  
Telex: (854) 17886 (via Spånga  
office)*

*Hewlett-Packard Sverige AB  
Skalholtsgränd 9, Kista  
Box 19  
S-16393 SPÅNGA  
Tel: (08) 750-2000  
Telex: (854) 17886  
Telefax: (08) 7527781  
A,CH,CM,CS,E,MS,P*

*Hewlett-Packard Sverige AB  
Frötältsgränd 30  
S-42132 VÄSTRA-FRÖLUNDA  
Tel: (031) 49-09-50  
Telex: (854) 17886 (via Spånga  
office)  
CH,E,P*

## SWITZERLAND

*Hewlett-Packard (Schweiz) AG  
Clarastrasse 12  
CH-4058 BASEL  
Tel: (61) 33-59-20  
A*

*Hewlett-Packard (Schweiz) AG  
7, rue du Bois-du-Lan  
Case Postale 365  
CH-1217 MEYRIN 2  
Tel: (0041) 22-83-11-11  
Telex: 27333 HPAG CH  
CH,CM,CS*

*Hewlett-Packard (Schweiz) AG  
Allmend 2  
CH-8967 WIDEN  
Tel: (0041) 57 31 21 11  
Telex: 53933 hpag ch  
Cable: HPAG CH  
A,CH,CM,CS,E,MS,P*

## SYRIA

*General Electronic Inc.  
Nuri Basha Ahnaf Ebn Kays Street  
P.O. Box 5781  
DAMASCUS  
Tel: 33-24-87  
Telex: 411 215  
Cable: ELECTROBOR DAMASCUS  
E*

*Middle East Electronics  
P.O.Box 2308  
Abu Rumaneh  
DAMASCUS  
Tel: 33 4 5 92  
Telex: 411 304  
M*

## TAIWAN

*Hewlett-Packard Far East Ltd.  
Kaohsiung Office  
2/F 68-2, Chung Cheng 3rd Road  
KAOHSIUNG  
Tel: (07) 241-2318  
CH,CS,E*

*Hewlett-Packard Far East Ltd.  
Taiwan Branch  
8th Floor  
337 Fu Hsing North Road  
TAIPEI*

*Ing Lih Trading Co.  
3rd Floor, 7 Jen-Ai Road, Sec. 2  
TAIPEI 100  
Tel: (02) 3948 191  
Cable: INGLIH TAIPEI  
A*

## THAILAND

*Unimesa  
30 Patpong Ave., Suriwong  
BANGKOK 5  
Tel: 235-5727  
Telex: 84439 Simonco TH  
Cable: UNIMESA Bangkok  
A,CH,CS,E,M*

*Bangkok Business Equipment Ltd.  
5/5-6 Dejo Road  
BANGKOK  
Tel: 234-8670, 234-8671  
Telex: 87669-BEQUIPT TH  
Cable: BUSIQUIPT Bangkok  
P*

## TRINIDAD & TOBAGO

*Caribbean Telecoms Ltd.  
50/A Jerningham Avenue  
P.O. Box 732  
PORT-OF-SPAIN  
Tel: 62-44213, 62-44214  
Telex: 235,272 HUGCO WG  
CM,E,M,P*

## TUNISIA

*Tunisie Electronique  
31 Avenue de la Liberte  
TUNIS*

*Tel: 280-144  
E,P  
Corema  
1 ter. Av. de Carthage  
TUNIS  
Tel: 253-821  
Telex: 12319 CABAM TN  
M*

## TURKEY

*Teknim Company Ltd.  
Iran Caddesi No. 7  
Kavaklıdere, ANKARA  
Tel: 275800  
Telex: 42155 TKNM TR  
E*

*E.M.A.  
Medina Eldem Sokak No.4 1/6  
Yuksel Caddesi  
ANKARA  
Tel: 175 622  
Telex: 42 591  
M*

## UNITED ARAB EMIRATES

*Emitac Ltd.  
P.O. Box 2711  
ABU DHABI  
Tel: 82 04 19-20  
Cable: EMITAC ABUDHABI  
Emitac Ltd.  
P.O. Box 1641  
SHARJAH  
Tel: 591 181  
Telex: 68136 Emitac Sh  
CH,CS,E,M,P*

## UNITED KINGDOM

*GREAT BRITAIN  
Hewlett-Packard Ltd.  
Trafalgar House  
Navigation Road  
ALTRINCHAM  
Cheshire WA14 1NU  
Tel: 061 928 6422  
Telex: 668068  
A,CH,CS,E,M,MS,P  
Hewlett-Packard Ltd.  
Elstree House, Elstree Way  
BOREHAMWOOD, Herts WD6 1SG  
Tel: 01 207 5000  
Telex: 89527 16  
E,CH,CS,P*

*Hewlett-Packard Ltd.  
Oakfield House, Oakfield Grove  
Clifton BRISTOL, Avon BS8 2BN  
Tel: 0272 736806  
Telex: 444302  
CH,CS,E,P*

*Hewlett-Packard Ltd.  
Bridewell House  
Bridewell Place  
LONDON EC4V 6BS  
Tel: 01 583 6565  
Telex: 298163  
CH,CS,P*

*Hewlett-Packard Ltd.  
Fourier House  
257-263 High Street  
LONDON COLNEY  
Herts. AL2 1HA, St. Albans  
Tel: 0727 24400  
Telex: 1-89527 16  
CH,CS*

*Hewlett-Packard Ltd.  
Pontefract Road  
NORMANTON, West Yorkshire WF6 1RN  
Tel: 0924 895566  
Telex: 557355  
CH,CS,P*

*Hewlett-Packard Ltd.  
The Quadrangle  
106-118 Station Road  
REDHILL, Surrey RH1 1PS  
Tel: 0737 68655  
Telex: 947234  
CH,CS,E,P*



# SALES & SUPPORT OFFICES

Arranged alphabetically by country

## GREAT BRITAIN (Cont'd)

Hewlett-Packard Ltd.  
Avon House  
435 Stratford Road  
Shirley, SOLIHULL, West Midlands  
B90 4BL  
Tel: 021 745 8800  
Telex: 339105  
CH,CS,E,P  
Hewlett-Packard Ltd.  
West End House  
41 High Street, West End  
**SOUTHAMPTON**  
Hampshire SO3 3OQ  
Tel: 04218 6767  
Telex: 477138  
CH,CS,P  
Hewlett-Packard Ltd.  
Eskdale Rd.  
Winnersh, WOKINGHAM  
Berkshire RG11 5OZ  
Tel: 0734 696622  
Telex: 848884  
E

Hewlett-Packard Ltd.  
King Street Lane  
Winnersh, WOKINGHAM  
Berkshire RG11 5AR  
Tel: 0734 784774  
Telex: 847178  
A,CH,CS,E,M,MP,P  
Hewlett-Packard Ltd.  
Nine Mile Ride  
Easthampstead, WOKINGHAM  
Berkshire, 3RG11 3LL  
Tel: 0344 773100  
Telex: 848805  
CH,CS,E,P

## IRELAND

**NORTHERN IRELAND**  
Hewlett-Packard Ltd.  
Cardiac Services Building  
95A Finaghy Road South  
**BELFAST BT10 0BY**  
Tel: 0232 625-566  
Telex: 747626  
CH,CS

## SCOTLAND

Hewlett-Packard Ltd.  
**SOUTH QUEENSFERRY**  
West Lothian, EH30 9TG  
Tel: 031 331 1188  
Telex: 72682  
CH,CM,CS,E,M,P

## UNITED STATES

**Alabama**  
Hewlett-Packard Co.  
700 Century Park South, Suite 128  
**BIRMINGHAM, AL 35226**  
Tel: (205) 822-6802  
A,CH,M  
Hewlett-Packard Co.  
420 Wynn Orive  
**HUNTSVILLE, AL 35805**  
P.O. Box 7700  
**HUNTSVILLE, AL 35807**  
Tel: (205) 830-2000  
CH,CM,CS,E,M\*

**Arizona**  
Hewlett-Packard Co.  
8080 Pointe Parkway West  
**PHOENIX, AZ 85044**  
Tel: (602) 273-8000  
A,CH,CM,CS,E,MS

Hewlett-Packard Co.  
2424 East Aragon Road  
**TUCSON, AZ 85706**  
Tel: (602) 889-4631  
CH,E,MS\*

**California**  
Hewlett-Packard Co.  
99 South Hill Or.  
**BRISBANE, CA 94005**  
Tel: (415) 330-2500  
CH,CS  
Hewlett-Packard Co.  
P.O. Box 7830 (93747)  
5060 E. Clinton Avenue, Suite 102  
**FRESNO, CA 93727**  
Tel: (209) 252-9652  
CH,CS,MS

Hewlett-Packard Co.  
P.O. Box 4230  
1430 East Orangethorpe  
**FULLERTON, CA 92631**  
Tel: (714) 870-1000  
CH,CM,CS,E,MP  
Hewlett-Packard Co.  
320 S. Kellogg, Suite B  
**GOLETA, CA 93117**  
Tel: (805) 967-3405  
CH

Hewlett-Packard Co.  
5400 W. Rosecrans Boulevard  
**LAWNDALE, CA 90260**  
P.O. Box 92105

LOS ANGELES, CA 90009  
Tel: (213) 970-7500  
Telex: 910-325-6608  
CH,CM,CS,MP

Hewlett-Packard Co.  
3155 Porter Oaks Drive  
**PALO ALTO, CA 94304**  
Tel: (415) 857-8000  
CH,CS,E

Hewlett-Packard Co.  
4244 So. Market Court, Suite A  
P.O. Box 15976  
**SACRAMENTO, CA 95852**  
Tel: (916) 929-7222  
A\*,CH,CS,E,MS

Hewlett-Packard Co.  
9606 Aero Drive  
P.O. Box 23333

**SAN DIEGO, CA 92139**

Tel: (619) 279-3200

CH,CM,CS,E,MP

Hewlett-Packard Co.  
2305 Camino Ramon "C"  
**SAN RAMON, CA 94583**

Tel: (415) 838-5900

CH,CS

Hewlett-Packard Co.  
3005 Scott Boulevard  
**SANTA CLARA, CA 95050**

Tel: (408) 988-7000

Telex: 910-338-0586

A,CH,CM,CS,E,MP

Hewlett-Packard Co.  
5703 Corsa Avenue  
**WESTLAKE VILLAGE, CA 91362**

Tel: (213) 706-6800

E\*,CH\*,CS\*

**Colorado**  
Hewlett-Packard Co.  
24 Inverness Place, East  
**ENGLEWOOD, CO 80112**

Tel: (303) 649-5000

A,CH,CM,CS,E,MS

**Connecticut**  
Hewlett-Packard Co.  
47 Barnes Industrial Road South  
P.O. Box 5007  
**WALLINGFORD, CT 06492**  
Tel: (203) 265-7801  
A,CH,CM,CS,E,MS

**Florida**  
Hewlett-Packard Co.  
2901 N.W. 62nd Street  
P.O. Box 24210  
**FORT LAUDERDALE, FL 33307**

Tel: (305) 973-2600  
CH,CS,E,MP

Hewlett-Packard Co.  
6177 Lake Ellenor Orive  
P.O. Box 13910  
**ORLANDO, FL 32859**

Tel: (305) 859-2900

A,CH,CM,CS,E,MS  
Hewlett-Packard Co.  
5750B N. Hoover Blvd., Suite 123

P.O. Box 15200

**TAMPA, FL 33614**

Tel: (813) 884-3282

A\*,CH,CM,CS,E\*,M\*

**Georgia**  
Hewlett-Packard Co.  
2000 South Park Place  
P.O. Box 105005

**ATLANTA, GA 30348**

Tel: (404) 955-1500

Telex: 810-766-4890

A,CH,CM,CS,E,MP

**Hawaii**  
Hewlett-Packard Co.  
Kawaihao Plaza, Suite 190

567 South King Street

**HONOLULU, HI 96813**

Tel: (808) 526-1555

A,CH,E,MS

**Illinois**  
Hewlett-Packard Co.  
304 Eldorado Road  
P.O. Box 1607

**BLOOMINGTON, IL 61701**

Tel: (309) 662-9411

CH,MS\*\*

Hewlett-Packard Co.  
1100 31st Street, Suite 100  
**DOWNTOWN GROVE, IL 60515**

Tel: (312) 960-5760

CH,CS

Hewlett-Packard Co.  
5201 Tollview Orive  
**ROLLING MEADOWS, IL 60008**

Tel: (312) 255-9800

Telex: 910-687-1066

A,CH,CM,CS,E,MP

**Indiana**  
Hewlett-Packard Co.  
7301 No. Shadeland Avenue  
P.O. Box 50807

**INDIANAPOLIS, IN 46250**

Tel: (317) 842-1000

A,CH,CM,CS,E,MS

**Iowa**  
Hewlett-Packard Co.  
1776 22nd Street, Suite 1  
**WEST DES MOINES, IA 50265**

Tel: (515) 224-1435

CH,MS\*\*

**Kansas**  
Hewlett-Packard Co.  
7804 East Funston Road, #203  
**WICHITA, KS 67207**

Tel: (316) 684-8491

CH

**Kentucky**  
Hewlett-Packard Co.  
10300 Linn Station Road, #100  
**LOUISVILLE, KY 40223**

Tel: (502) 426-0100

A,CH,CS,MS

**Louisiana**  
Hewlett-Packard Co.  
160 James Orive East  
**ST. ROSE, LA 70087**

P.O. Box 1449

**KENNER, LA 70063**

Tel: (504) 467-4100

A,CH,CS,E,MS

**Maryland**  
Hewlett-Packard Co.  
3701 Koppers Street  
**BALTIMORE, MD 21227**

Tel: (301) 644-5800

Telex: 710-862-1943

A,CH,CM,CS,E,MS

**Massachusetts**  
Hewlett-Packard Co.  
1775 Minuteman Road  
**ANDOVER, MA 01810**

Tel: (617) 682-1500

A,C,CH,CS,CM,E,MP,P\*

Hewlett-Packard Co.  
32 Hartwell Avenue  
**LEXINGTON, MA 02173**

Tel: (617) 861-8960

CH,CS,E

**Michigan**  
Hewlett-Packard Co.  
4326 Cascade Road S.E.  
**GRAND RAPIDS, MI 49506**

Tel: (616) 957-1970

CH,CS,MS

Hewlett-Packard Co.  
1771 W. Big Beaver Road  
**TROY, MI 48084**

Tel: (313) 643-6474

CH,CS

**Minnesota**  
Hewlett-Packard Co.  
2025 W. Larpeinteur Ave.  
**ST. PAUL, MN 55113**

Tel: (612) 644-1100

A,CH,CM,CS,E,MP

**Missouri**  
Hewlett-Packard Co.  
11131 Colorado Avenue  
**KANSAS CITY, MO 64137**

Tel: (816) 763-8000

A,CH,CM,CS,E,MS

Hewlett-Packard Co.  
13001 Hollenberg Drive  
**BRIDGETON, MO 63044**

Tel: (314) 344-5100

A,CH,CS,E,MP



# SALES & SUPPORT OFFICES

Arranged alphabetically by country

## UNITED STATES (Cont'd)

### **Nebraska**

Hewlett-Packard  
10824 Old Mill Rd., Suite 3  
OMAHA, NE 68154  
Tel: (402) 334-1813  
CM,MS

### **New Jersey**

Hewlett-Packard Co.  
120 W. Century Road  
PARAMUS, NJ 07652  
Tel: (201) 265-5000  
A,CH,CM,CS,E,MP  
Hewlett-Packard Co.  
60 New England Av. West  
PISCATAWAY, NJ 08854  
Tel: (201) 981-1199  
A,CH,CM,CS,E

### **New Mexico**

Hewlett-Packard Co.  
11300 Lomas Blvd., N.E.  
P.O. Box 11634  
ALBUQUERQUE, NM 87112  
Tel: (505) 292-1330  
CH,CS,E,MS

### **New York**

Hewlett-Packard Co.  
5 Computer Drive South  
ALBANY, NY 12205  
Tel: (518) 458-1550  
A,CH,E,MS  
Hewlett-Packard Co.  
9600 Main Street  
P.O. Box AC  
CLARENCE, NY 14031  
Tel: (716) 759-8621  
CH

Hewlett-Packard Co.  
200 Cross Keys Office Park  
FAIRPORT, NY 14450

Tel: (716) 223-9950  
CH,CM,CS,E,MS

Hewlett-Packard Co.

7641 Henry Clay Blvd.  
LIVERPOOL, NY 13088  
Tel: (315) 451-1820  
A,CH,CM,E,MS

Hewlett-Packard Co.  
No. 1 Pennsylvania Plaza  
55th Floor

34th Street & 8th Avenue  
MANHATTAN NY 10119  
Tel: (212) 971-0800  
CH,CS,E,M\*

Hewlett-Packard Co.  
250 Westchester Avenue  
WHITE PLAINS, NY 10604

Tel: (914) 684-6100  
CM,CH,CS,E

Hewlett-Packard Co.  
3 Crossways Park West  
WOODBURY, NY 11797  
Tel: (516) 921-0300  
A,CH,CM,CS,E,MS

### **North Carolina**

Hewlett-Packard Co.  
5605 Roanoke Way  
P.O. Box 26500  
GREENSBORO, NC 27420  
Tel: (919) 852-1800  
A,CH,CM,CS,E,MS

### **Ohio**

Hewlett-Packard Co.  
9920 Carver Road  
CINCINNATI, OH 45242  
Tel: (513) 891-9870  
CH,CS,MS

### **Oklahoma**

Hewlett-Packard Co.  
330 Progress Rd.  
DAYTON, OH 45449  
Tel: (513) 859-8202  
A,CH,CM,E\*,MS

### **Oregon**

Hewlett-Packard Co.  
3840 S. 103rd E. Avenue, #100  
P.O. Box 35747  
TULSA, OK 74153  
Tel: (918) 665-3300  
A\*\*,CH,CS,M\*

### **Pennsylvania**

Hewlett-Packard Co.  
111 Zeta Drive  
PITTSBURGH, PA 15238  
Tel: (412) 782-0400  
A,CH,CS,E,MP

### **South Carolina**

Hewlett-Packard Co.  
Brookside Park, Suite 122  
1 Harbison Way  
P.O. Box 21708  
COLUMBIA, SC 29221  
Tel: (803) 732-0400  
CH,E,MS

### **Tennessee**

Hewlett-Packard Co.  
Koger Executive Center  
Chesterfield Bldg., Suite 124  
GREENVILLE, SC 29615  
Tel: (803) 297-4120

Hewlett-Packard Co.  
224 Peters Road, Suite 102  
P.O. Box 22490  
KNOXVILLE, TN 37922  
Tel: (615) 691-2371  
A\*,CH,MS

### **Texas**

Hewlett-Packard Co.  
3070 Directors Row  
MEMPHIS, TN 38131  
Tel: (901) 346-8370  
A,CH,MS

### **Texas**

Hewlett-Packard Co.  
4171 North Mesa  
Suite C-110  
EL PASO, TX 79902  
Tel: (915) 533-3555  
CH,E\*,MS\*\*

### **Texas**

Hewlett-Packard Co.  
10535 Harwin Drive  
P.O. Box 42816  
HOUSTON, TX 77042  
Tel: (713) 776-6400  
A,CH,CM,CS,E,MP

### **Texas**

Hewlett-Packard Co.  
930 E. Campbell Rd.  
P.O. Box 1270  
RICHARDSON, TX 75080  
Tel: (214) 231-6101  
A,CH,CM,CS,E,MP

### **Texas**

Hewlett-Packard Co.  
1020 Central Parkway South  
P.O. Box 32993  
SAN ANTONIO, TX 78216  
Tel: (512) 494-9336  
CH,CS,E,MS

### **Utah**

Hewlett-Packard Co.  
3530 W. 2100 South  
SALT LAKE CITY, UT 84119

### **Utah**

Hewlett-Packard Co.  
4305 Cox Road  
GLEN ALLEN, VA 23060  
P.O. Box 9669  
RICHMOND, VA 23228  
Tel: (804) 747-7750  
A,CH,CS,E,MS

### **Virginia**

Hewlett-Packard Co.  
15815 S.E. 37th Street  
BELLEVUE, WA 98006  
Tel: (206) 643-4000  
A,CH,CM,CS,E,MP

### **Washington**

Hewlett-Packard Co.  
708 North Argonne Road  
SPOKANE, WA 99212  
Tel: (509) 922-7000  
CH,CS

### **West Virginia**

Hewlett-Packard Co.  
4604 MacCorkle Ave.  
P.O. Box 4297  
CHARLESTON, WV 25304  
Tel: (304) 925-0492  
A,MS

### **Wisconsin**

Hewlett-Packard Co.  
150 S. Sunny Slope Road  
BROOKFIELD, WI 53005  
Tel: (414) 784-8800  
A,CH,CS,E\*,MP

## URUGUAY

Pablo Ferrando S.A.C. e I.  
Avenida Italia 2877  
Casilla de Correo 370  
MONTEVIDEO  
Tel: 80-2586  
Telex: Public Booth 901  
A,CM,E,M

## VENEZUELA

Hewlett-Packard de Venezuela C.A.  
3RA Transversal Los Ruices Norte  
Edificio Segre 1, 2 & 3  
Apartado 50933  
CARACAS 1071  
Tel: 239-4133  
Telex: 251046 HEWPACK  
A,CH,CS,E,MS,P

Hewlett-Packard de Venezuela C.A.  
Calle 72-Entre 3H y 3Y, No. 3H-40  
Edificio Ada-Evelyn, Local B  
Apartado 2646  
4001, MARACAIBO, Estado Zulia  
Tel: (061) 80.304  
C,E\*

Hewlett-Packard de Venezuela C.A.  
Calle Vargas Rondon .  
Edificio Seguros Carabobo, Piso 10  
VALENCIA  
Tel: (041) 51 385  
CH,CS,P

Bioelectronica Medica C.A.  
Calle Buen Pastor  
Edif. Cota Mil-Piso 2 y Semi Sotano 1  
Boleita Norte  
Apartado 50710 CARACAS 1050A  
Tel: 239 84 41  
Telex: 26518

## ZIMBABWE

Field Technical Sales  
45 Kelvin Road, North  
P.B. 3458  
SALISBURY  
Tel: 705 231  
Telex: 4-122 RH  
C,E,M,P

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